NLO event samples for the LHC

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and
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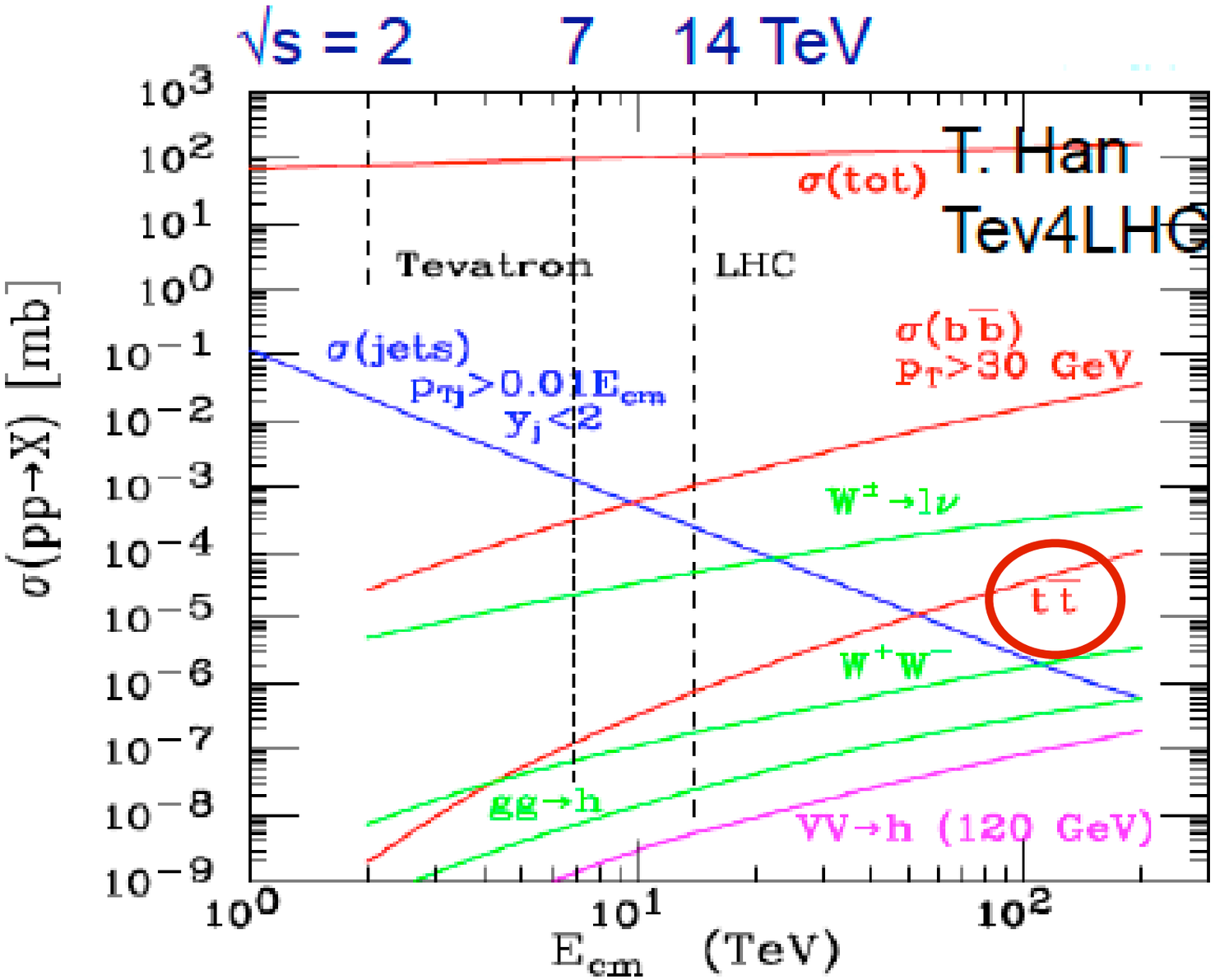
Outline

- Motivation
- Method
- Predictions
- Conclusions and Plans

Motivation

The importance of being top

1. The higher collider energy, the larger weight in total cross section



The importance of being top

1. The higher collider energy, the larger weight in total cross section
2. The t-quark is heavy, Yukawa coupling ~1

$$m_t = 172.0 \pm 0.9 \pm 1.3 \text{ (PDG) } 173.3 \pm 1.1 \text{ (TeVatron)}$$

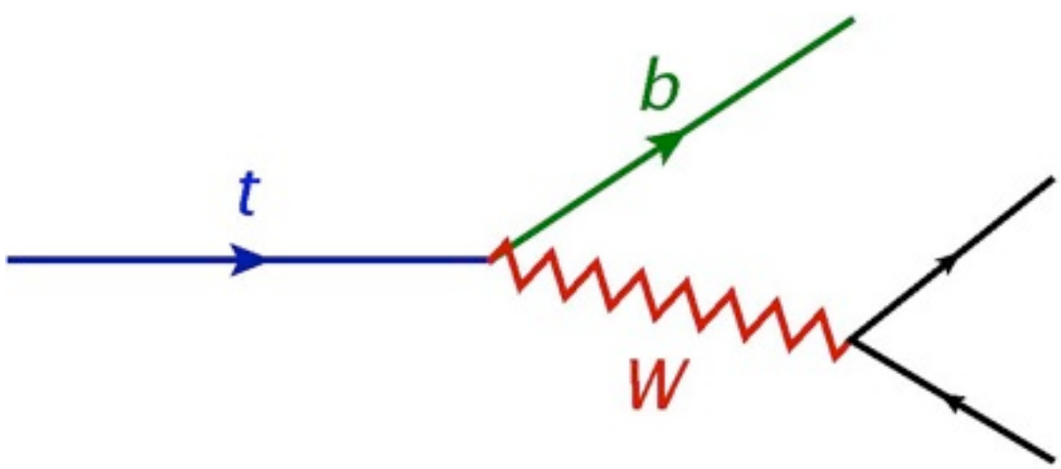
$\Rightarrow$ plays important role in Higgs physics

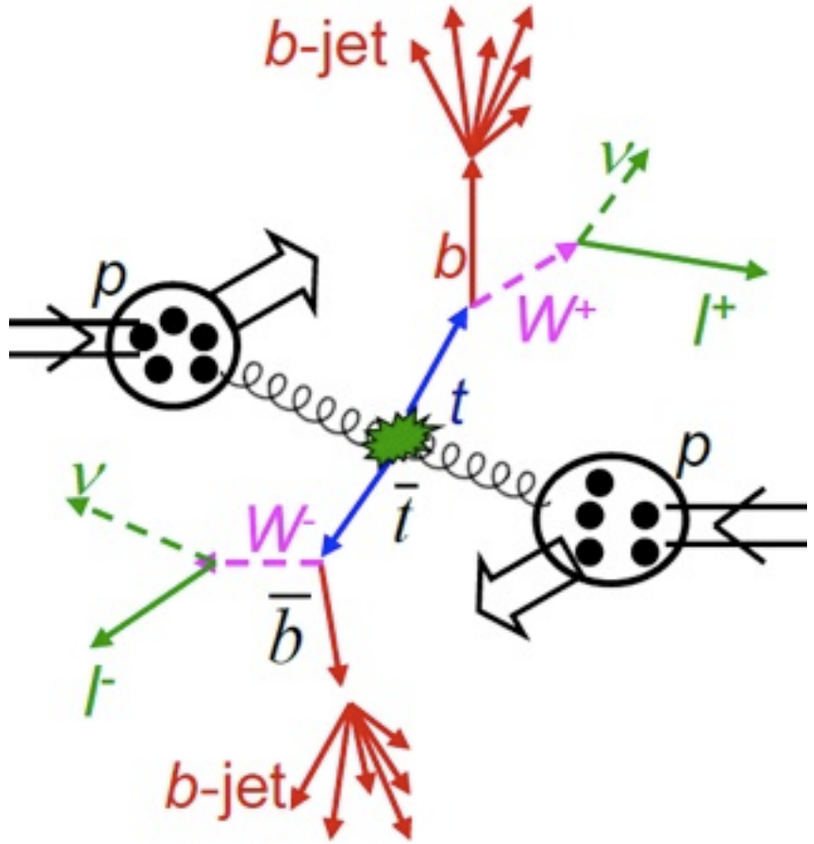
The importance of being top

1. The higher collider energy, the larger weight in total cross section
2. The t-quark is heavy, Yukawa coupling ~1
3. The t-quark decays before hadronization

   $\Rightarrow$ quantum numbers more accessible than in case of other quarks

$$|V_{tb}|^2 \gg |V_{ts}|^2,\ |V_{td}|^2$$





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(with decays, top is not detected)

Method

From NLO to NLO+PS

Idea: use NLO calculation as hard process as input for the SMC

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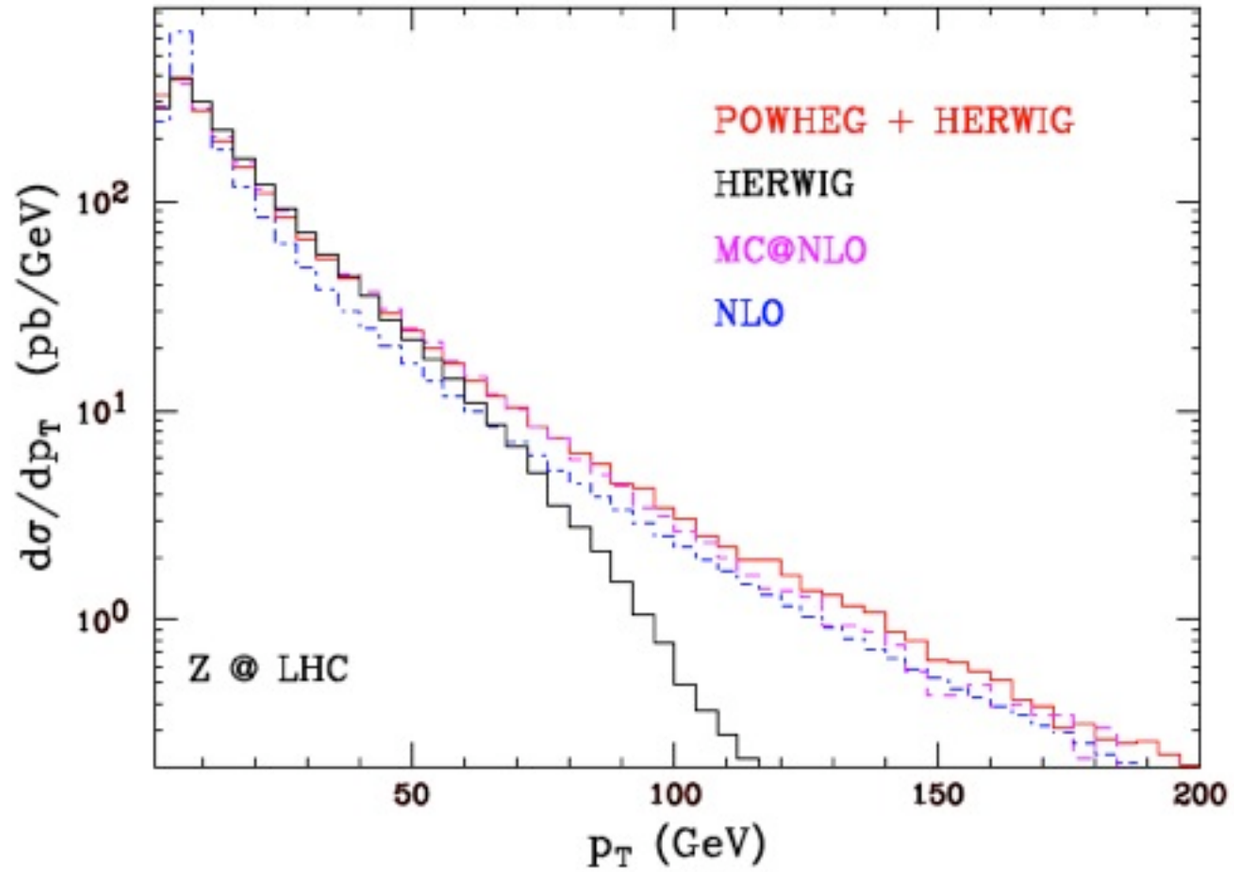
- POWHEG [Nason hep-ph/0409146, Frixione, Nason, Oleari arXiv:0709.2092]

Result: PS events giving distributions exact to NLO in pQCD



Nason, Ridolfi hep-ph/0606275

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- There is no implementation of truncated shower in HERWIG using external LHE event files, the effect of the truncated showers is absent from our predictions

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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

http://grid.kfki.hu/twiki/bin/view/DbTheory/WebHome#Events_with_NLO_accuracy_for_par

TWiki > DbTheory Web > TtjProd (2011-07-15, AdamKardos)

Top quark pair production in association with a jet

This page contains those event files which concern top quark pair production with a jet. The used code can be found here: ttj.tgz.

TeVatron @ 1.96 TeV

1. m_t = 172 GeV , \mu = \mu_R = \mu_F = m_t, CTEQ6M PDF, 2-loop running \alpha_s, p_{\bot,\mathrm{min}} = 5 GeV . This set was taken for comparison with Melnikov and Schulze(arXiv:1004.3284). ttj-tev-01.tgz (315 Mb)
2. m_t = 174 GeV , \mu = \mu_R = \mu_F = m_t, CTEQ6M PDF, 2-loop running \alpha_s, p_{\bot,\mathrm{min}} = 5 GeV . This set was taken for comparison with Dittmaier, Uwer and Weinzierl(arXiv:0810.0452). ttj-tev-02.tgz (152 Mb)

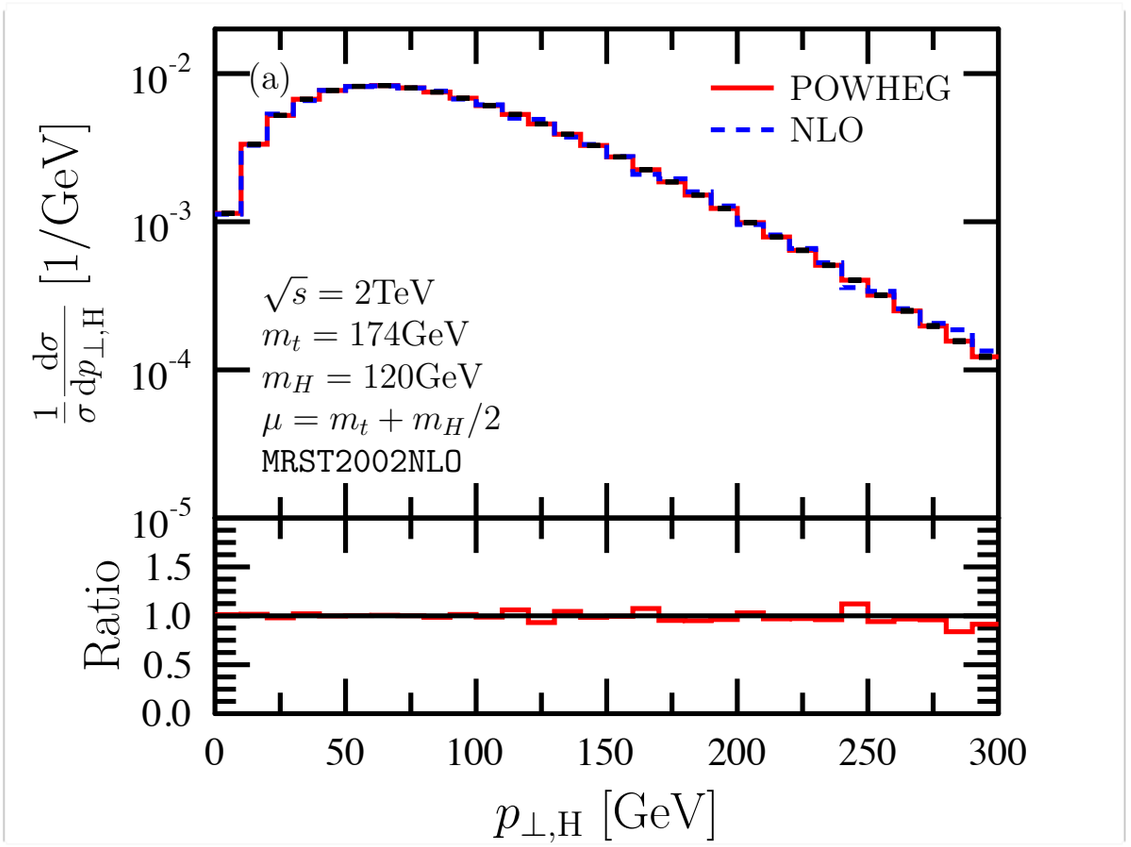
LHC @ 7 TeV

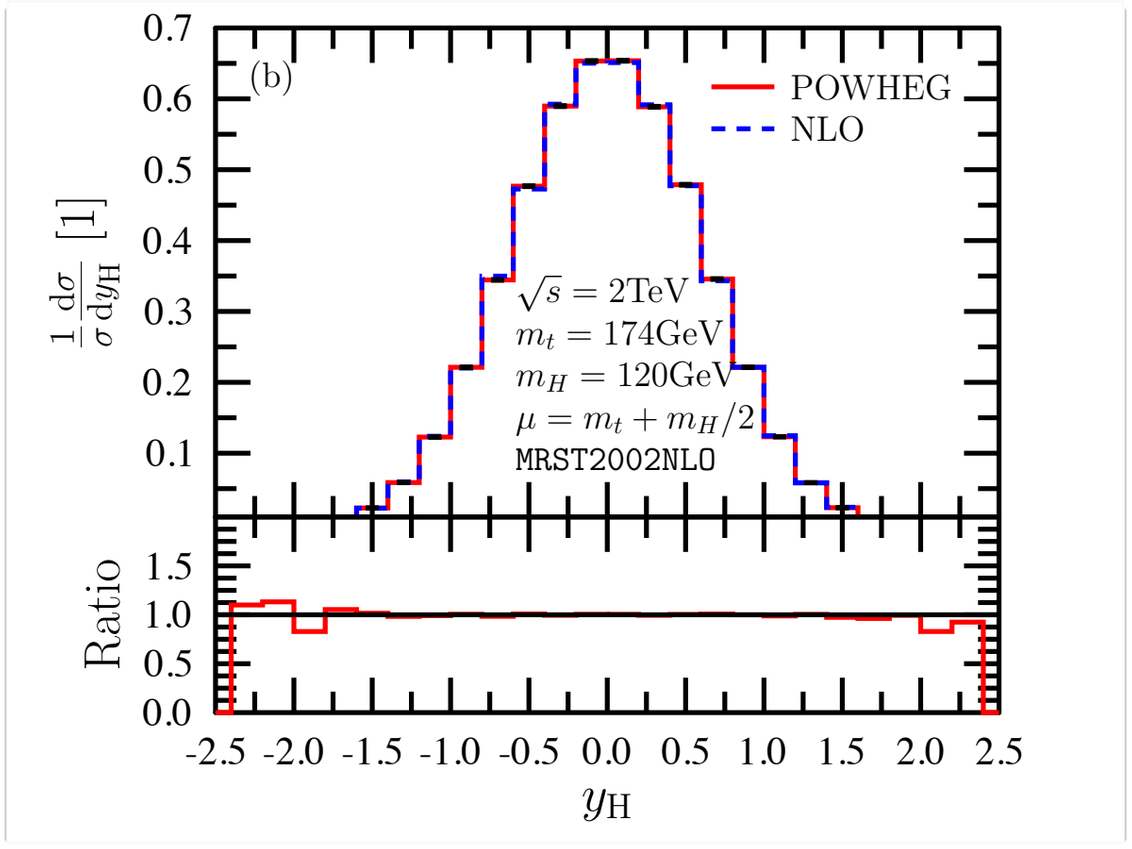
1. m_t = 172 GeV , \mu = \mu_R = \mu_F = m_t, CTEQ6M PDF, 2-loop running \alpha_s, p_{\bot,\mathrm{min}} = 5 GeV . To reproduce the predictions of arXiv:1101.2672. ttj-lhc-01.tgz (410 Mb)
2. m_t = 172 GeV , \mu = \mu_R = \mu_F = m_\bot (for a precise definition please see arXiv:1101.2672), CTEQ6M PDF, 2-loop running \alpha_s, p_{\bot,\mathrm{min}} = 5 GeV . To reproduce the predictions of arXiv:1101.2672. ttj-lhc-02.tgz (397 Mb)

Comparison to NLO

- ✓ Compare LO and NLO cross sections to published predictions
- ✓ Compare distributions based on events at Born+1st radiation level to those at NLO accuracy

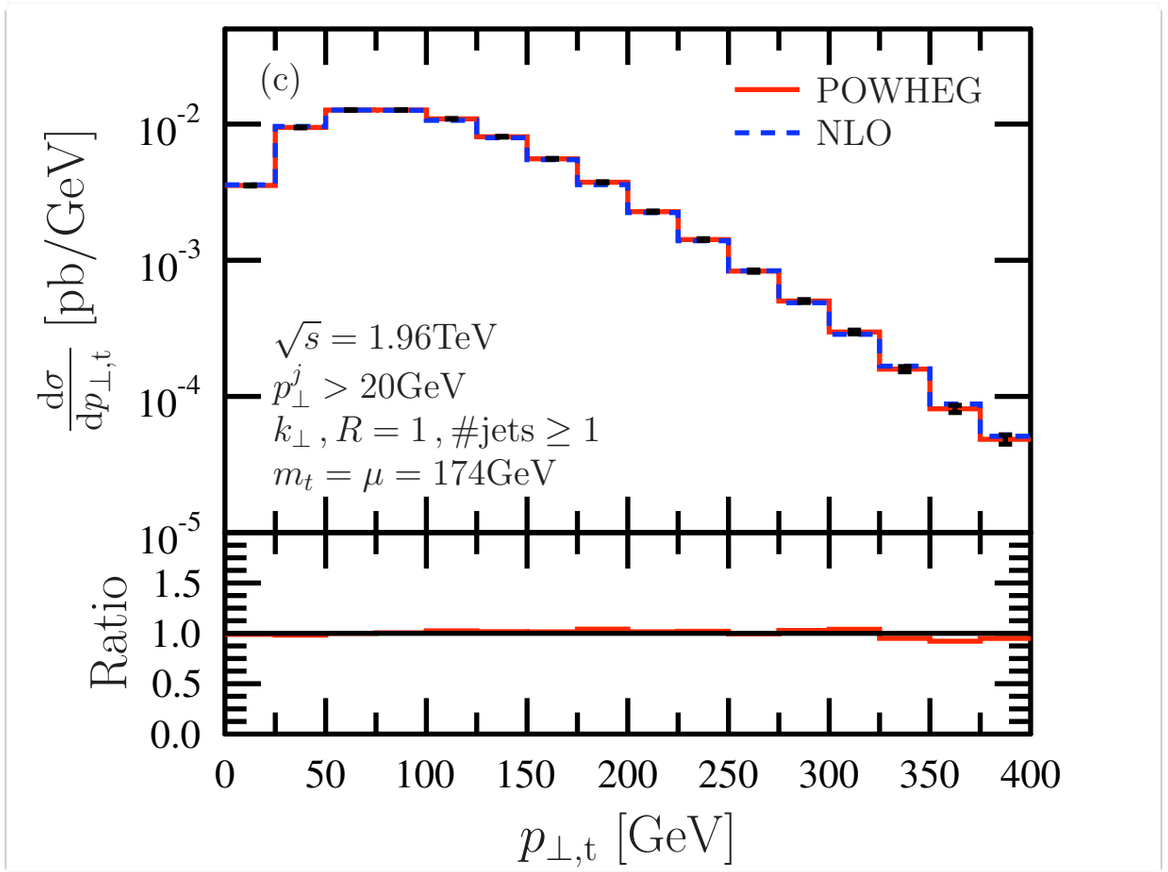
POWHEG vs. NLO

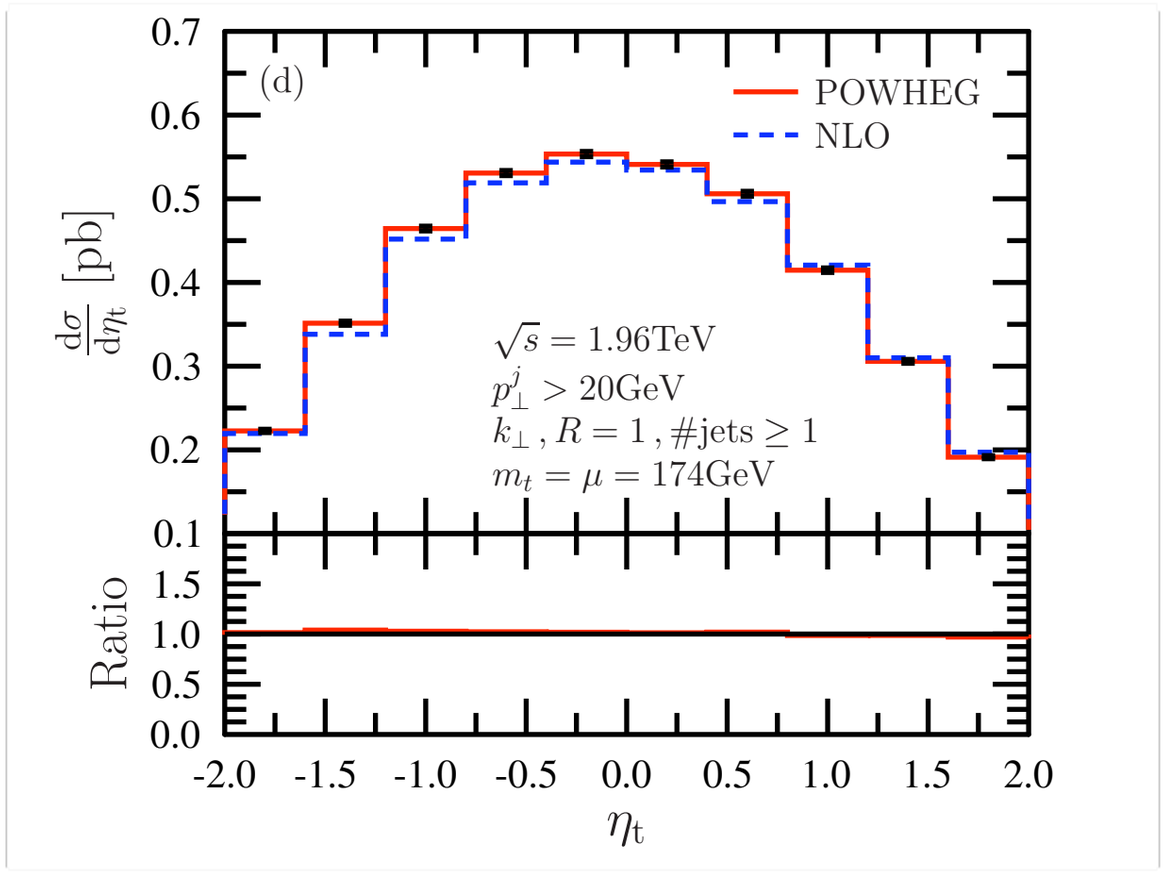




Transverse momentum and rapidity distributions of the Higgs boson in $p\bar{p} \to t\bar{t}\,H$ at the TeVatron

POWHEG vs. NLO





Transverse momentum and rapidity distributions of the t-quark in $p\bar{p} \rightarrow t\bar{t}$ jet at the TeVatron

Three levels of predictions

POWHEG: we use the events at BORN+1st radiation

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Number and type of particles are very different =>
the possible selection cuts are restricted in comparisons

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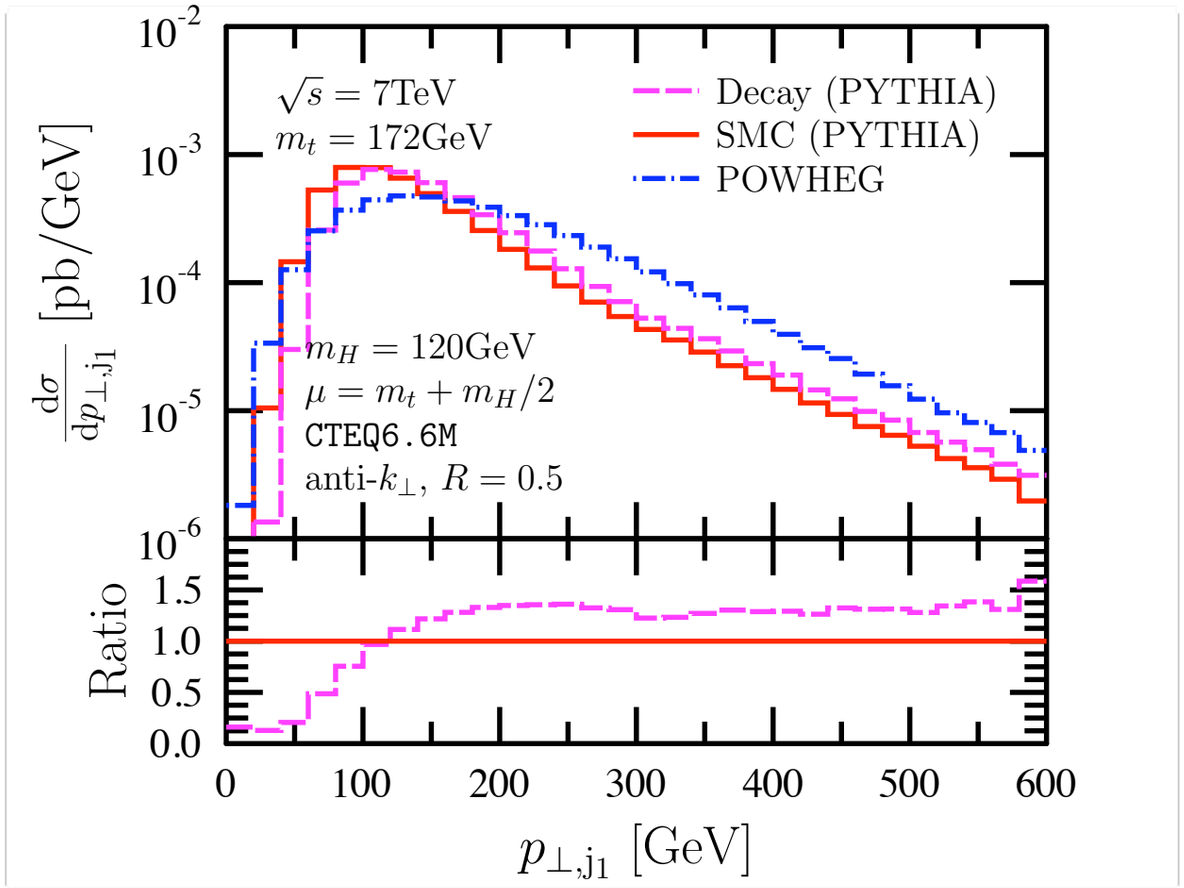
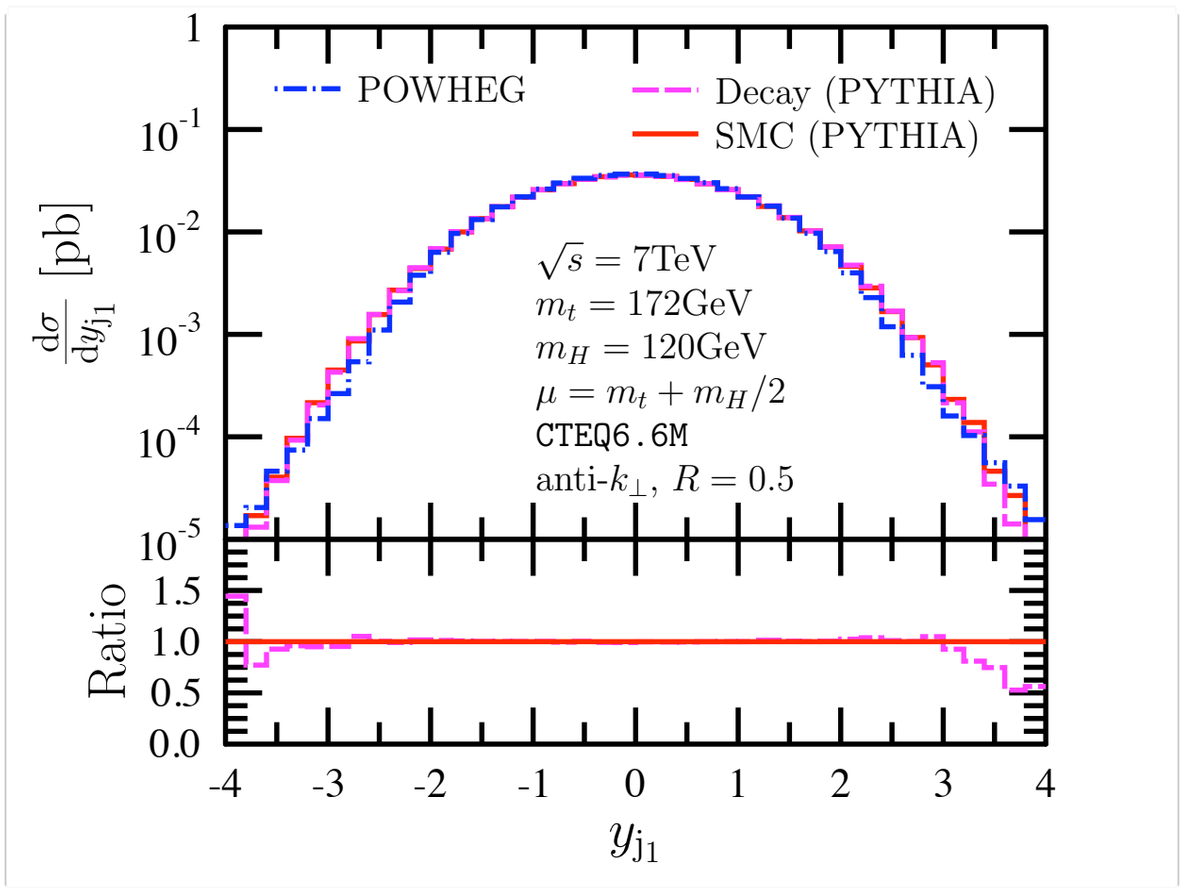
Jet cuts: to compare decay and full SMC predictions with physical cuts to the extent it is meaningful (leptons are very different at the two levels)

Physical cuts: to compare physical predictions from PYTHIA and HERWIG

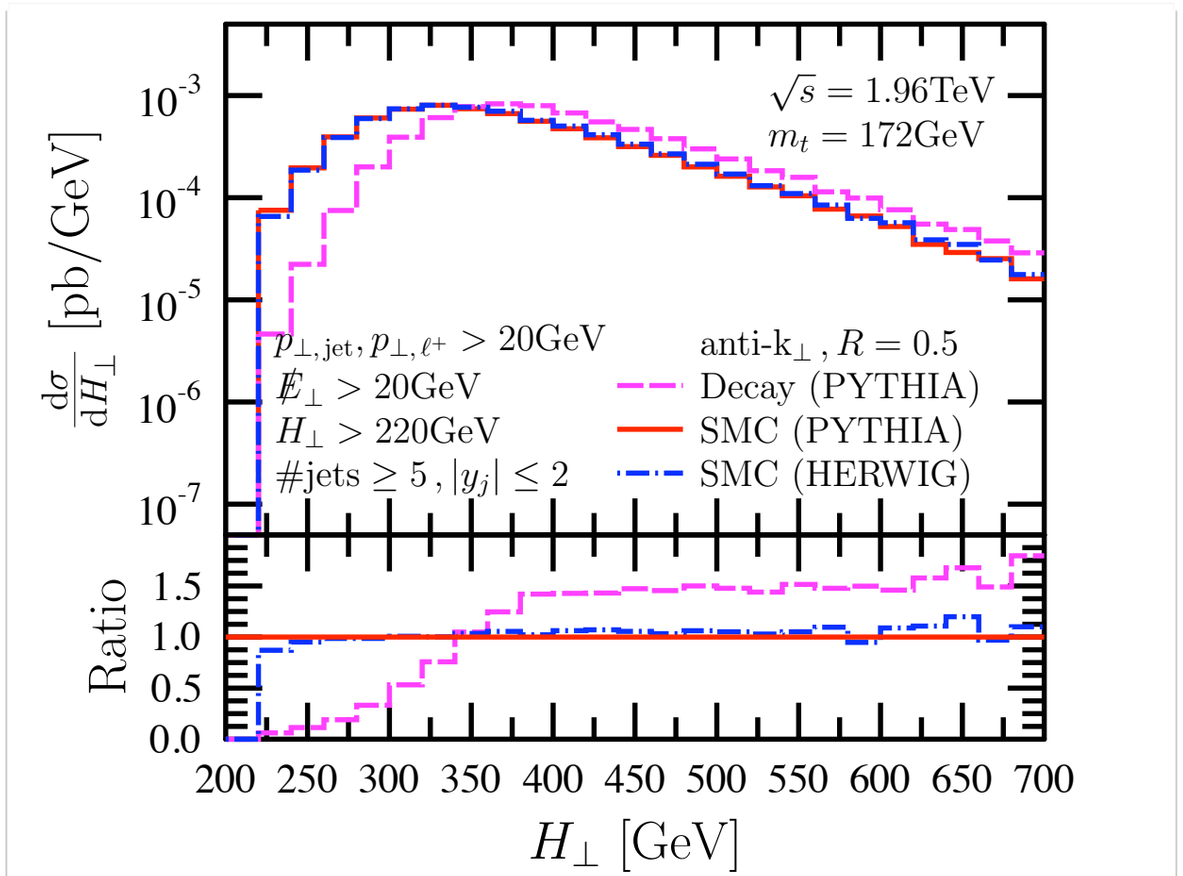
POWHEG vs. decay vs. full SMC, no cuts

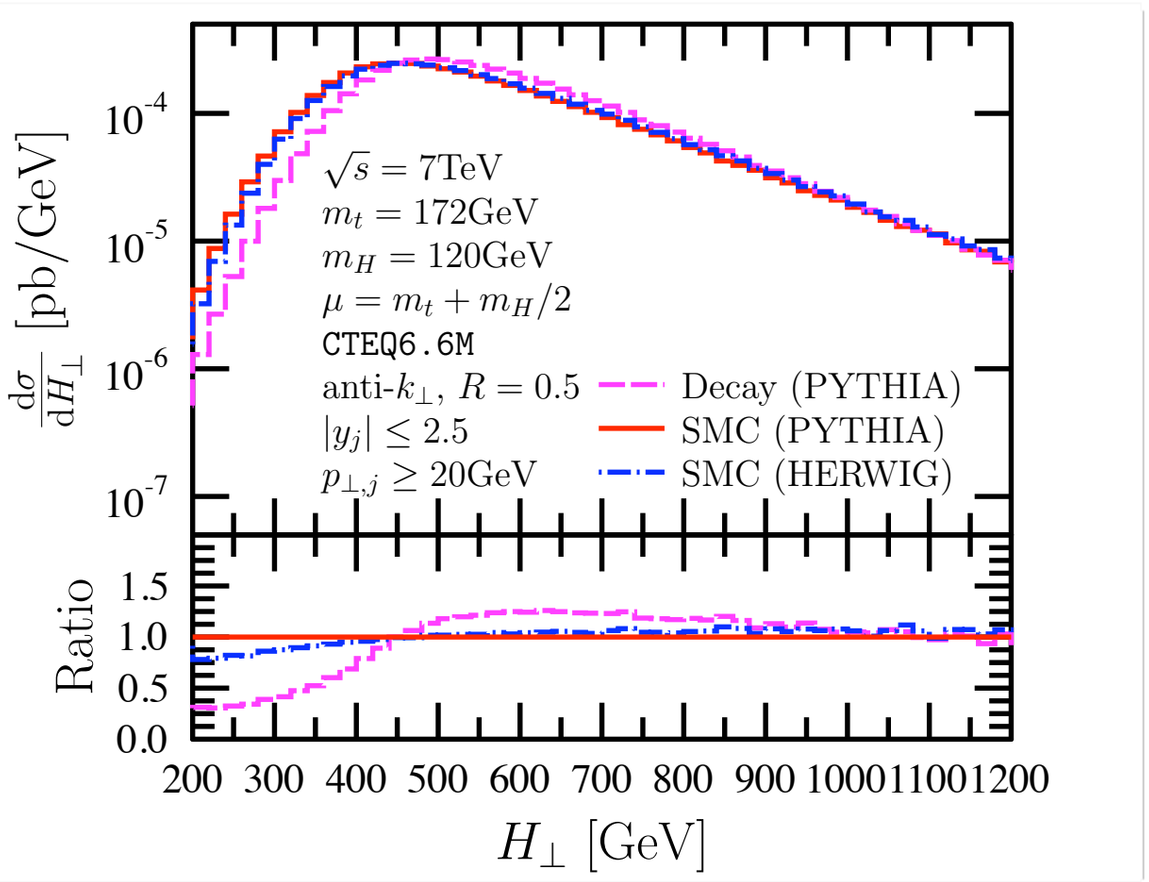




Transverse momentum and rapidity distributions of the hardest jet in $pp \to t\bar{t}H$ at the LHC

Decay vs. full SMC, jet cuts





H_T distributions in $p\bar{p} \to t\bar{t}$ jet at the TeVatron and $pp \to t\bar{t}H$ at the LHC

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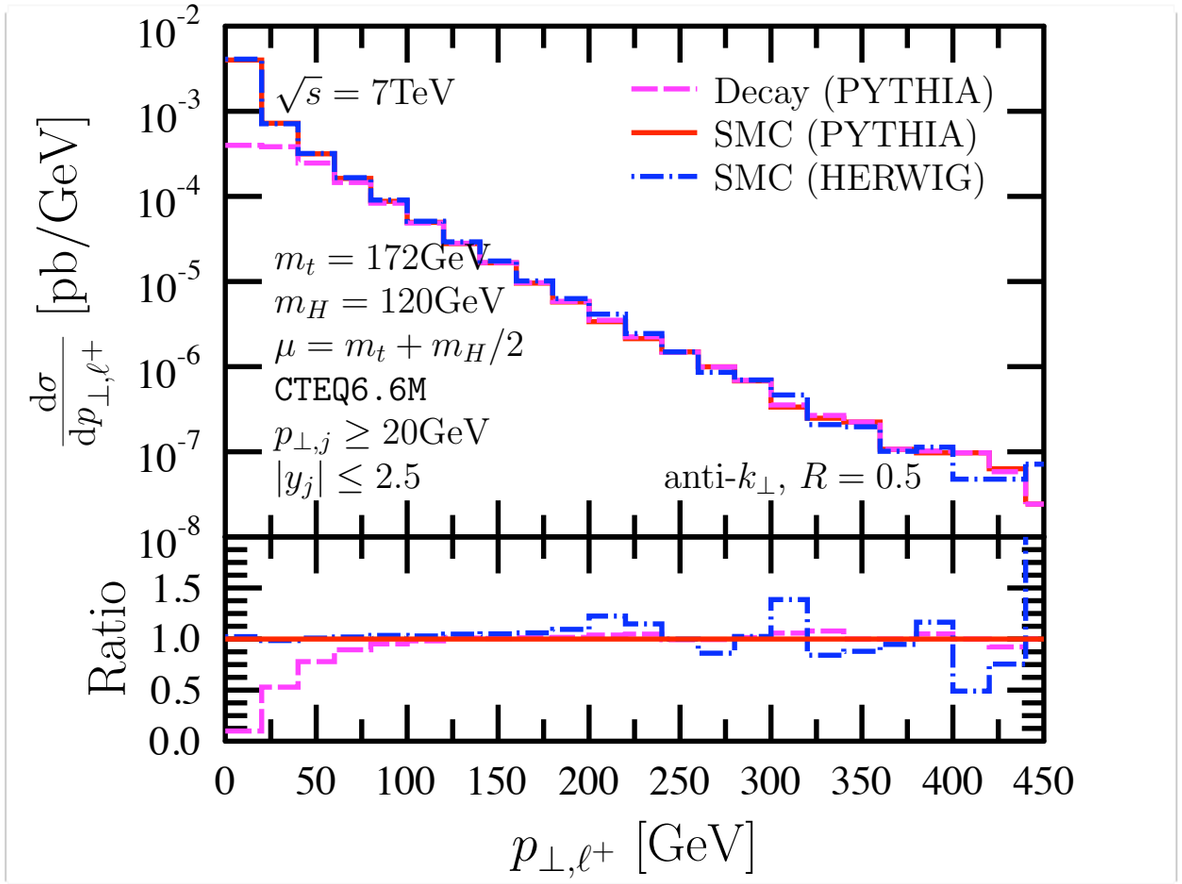
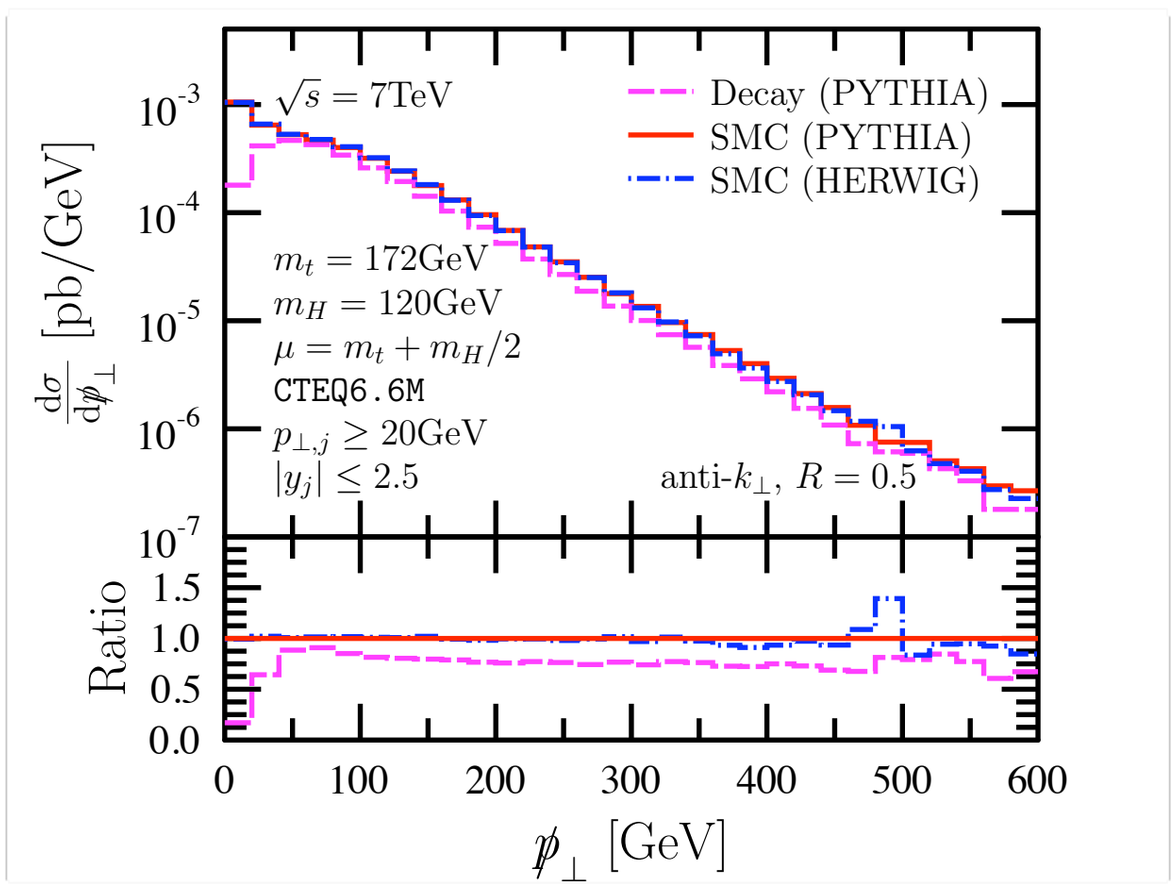
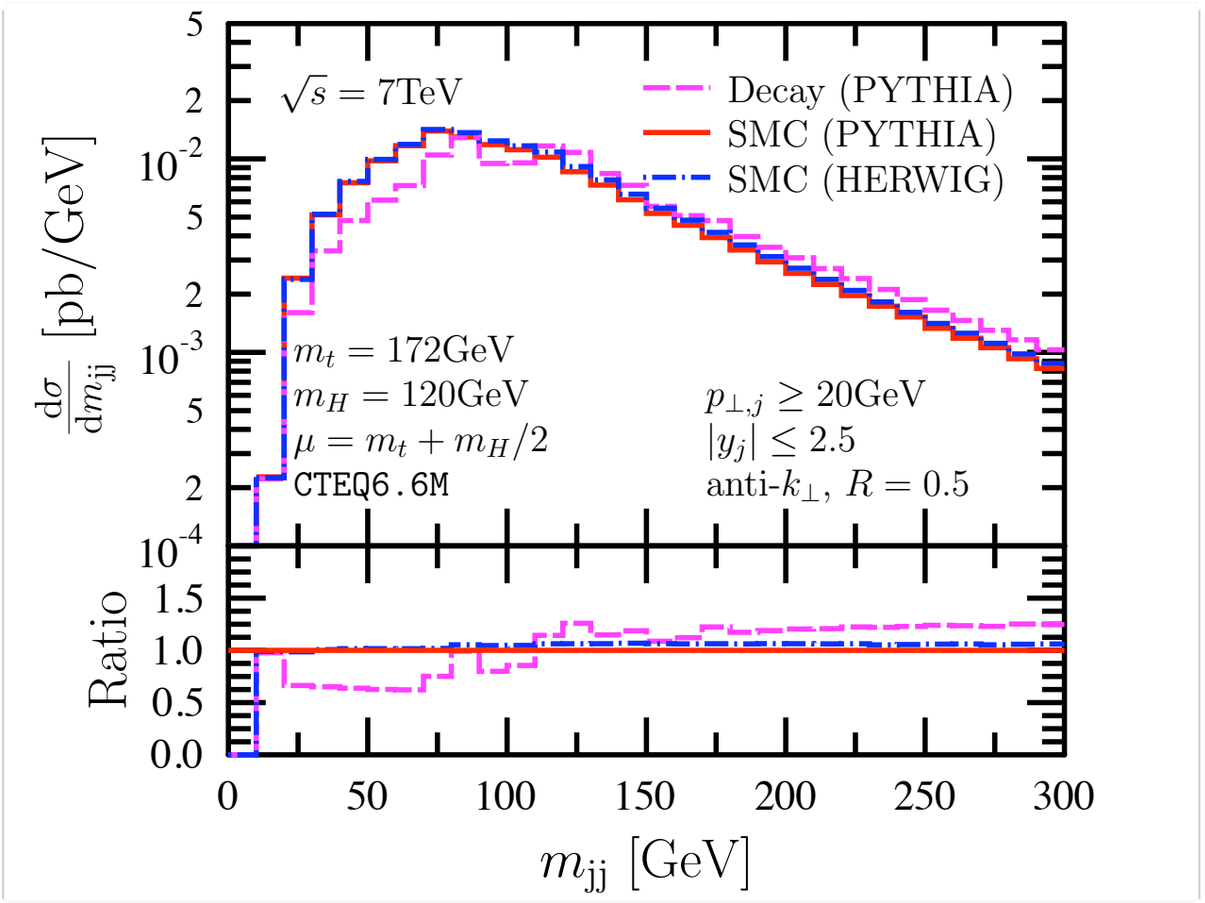


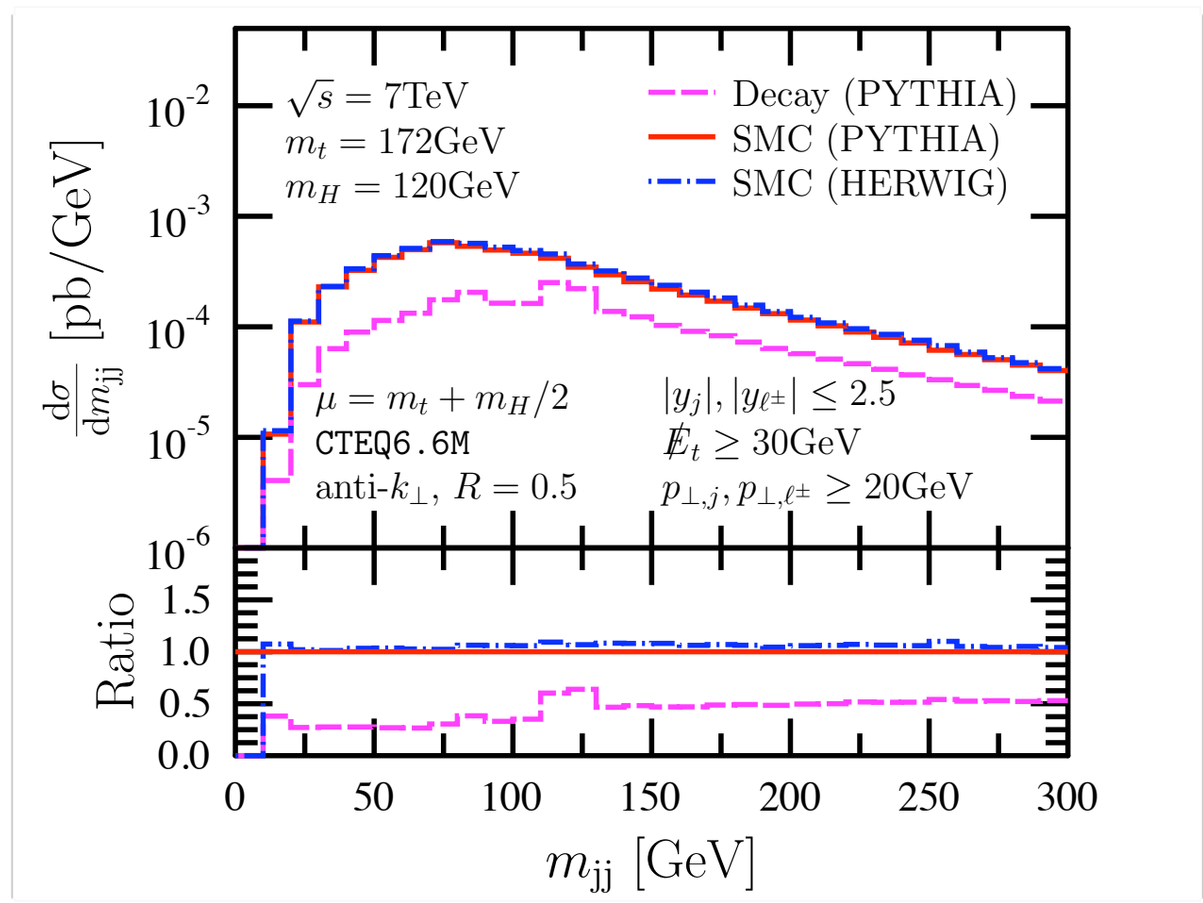


Lepton and missing p_T distributions in $pp \to t\bar{t}H$ at the LHC

Predictions

Decay vs. full SMC, physical cuts





jet-jet invariant mass distribution in $pp \to t\bar{t}H$ at the LHC

left: only jet cuts

right: physical cuts

Conclusions and outlook

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➡ Easy predictions for LHC with NLO+PS accuracy

Plans

- Study scale choices and dependences
- Generation of events on request
- Extension to further processes...

The end