The comparison study of the ratio between $t\bar{t}\gamma$ and $t\bar{t}$ in the $e\mu$ channel

Thuso Mathaha, Abhaya Kumar Swain, Bruce Mellado

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University of the Witwatersrand
School of Physics
Institute for Collider Particle Physics

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INSTITUTE FOR COLLIDER PARTICLE PHYSICS
UNIVERSITY OF THE WITWATERSRAND

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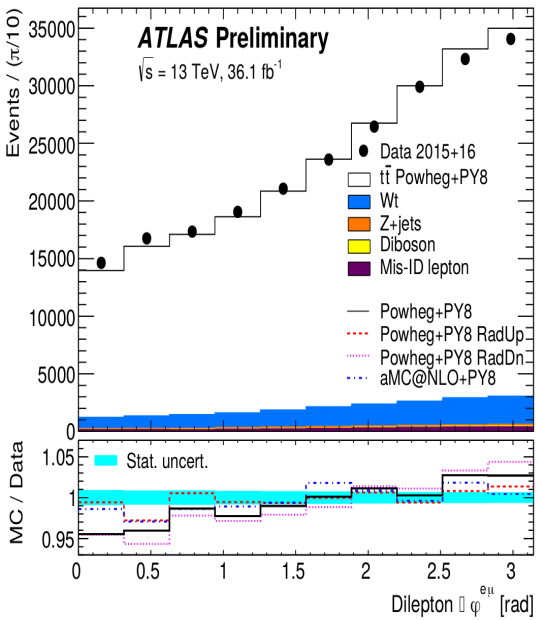
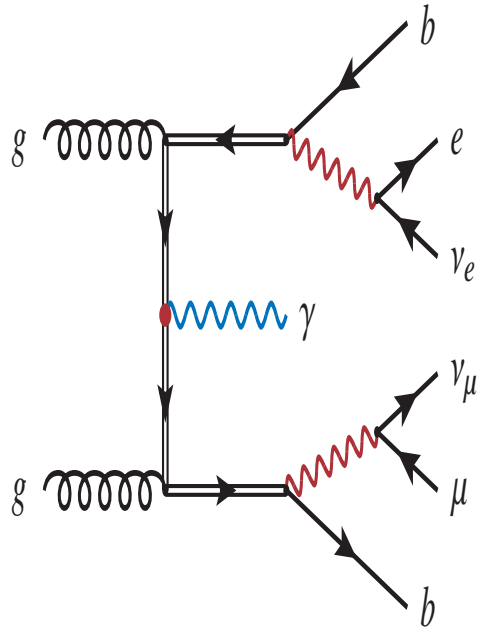
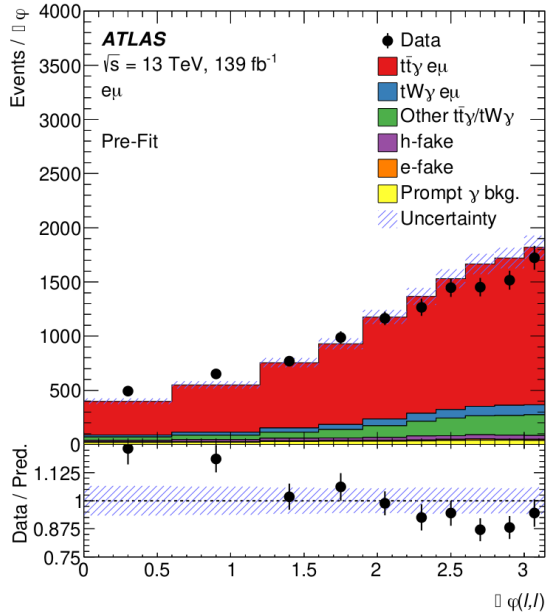
Introduction

- Precise measurements of top quark production and decay properties provide crucial information for testing the predictions of the SM.
- The study of the top quark pair allows QCD to be probed at some of the highest accessible energy scales.
- The large mass of the top quark, close to the scale of electroweak symmetry breaking, gives it a unique role in the SM and potential extensions.
- $t\bar{t}$ production forms an important background to many searches for physics beyond the SM.

Motivation







- There's a discrepancy between data and Monte Carlo simulation.
- We propose the use of ratio between the production of $t\bar{t}$ & $t\bar{t}\gamma$.
- This approach is complemented with production of the two processes at LO and NLO.
- The $e\mu$ channel is considered since it provides a clean final state with a small background contribution.

Event Selection

For both $t\bar{t}$ & $t\bar{t}\gamma$, we require the following:

- Require that there be an e & μ with $p_{\mathrm{T}} > 25\,\mathrm{GeV}$ and $|\eta| < 2.5$
- Require at least two jets with $p_{\mathrm{T}} > 25\,\mathrm{GeV}$ and $|\eta| < 2.5$
- Require at least one b-tagged jet with $p_{\mathrm{T}} > 25\,\mathrm{GeV}$ and $|\eta| < 2.5$

For $t\bar{t}\gamma$, there is a further requirement:

- Require the photon with $p_{\mathrm{T}} > 20\,\mathrm{GeV}$ and $|\eta| < 2.37$

Cross-sections

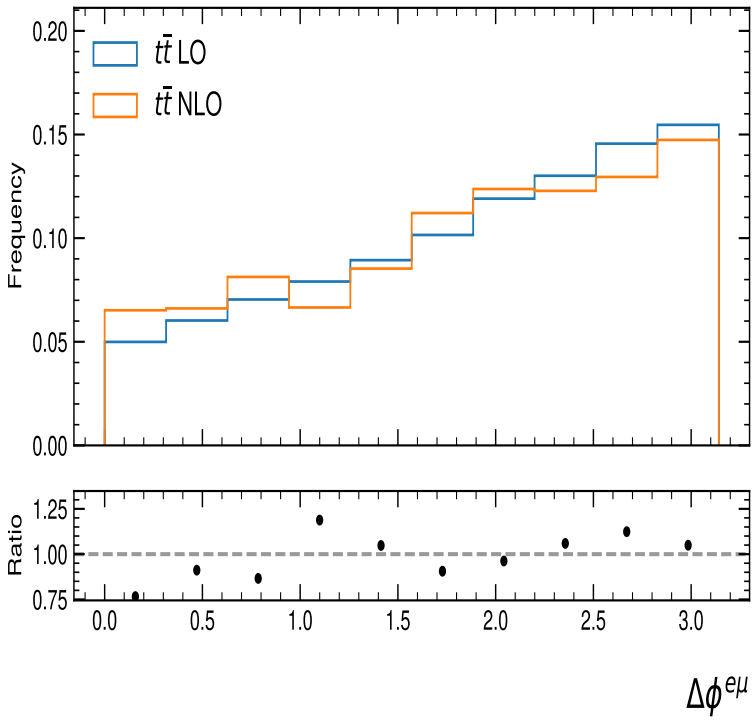
For $t\bar{t}$ the cross sections at LO and NLO were found to be :

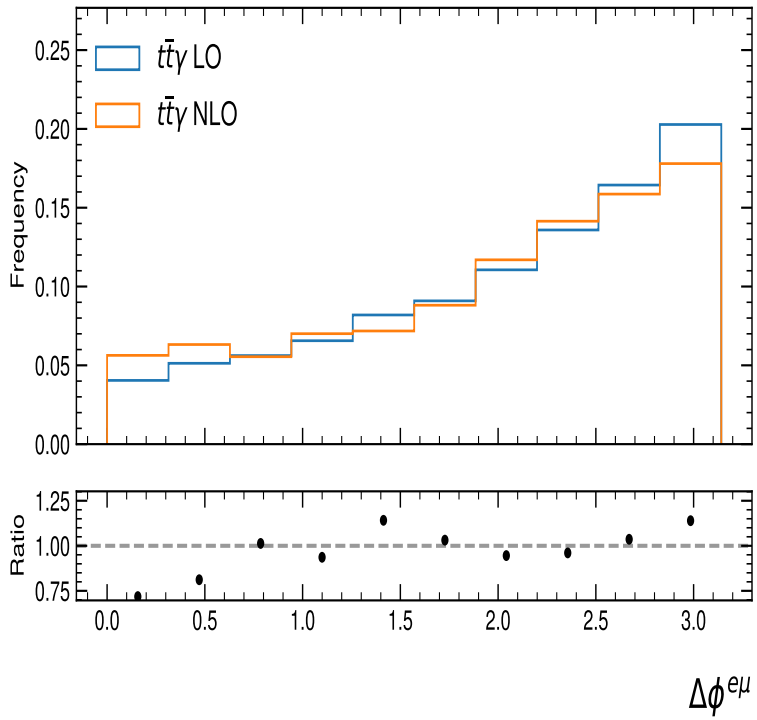
- $\sigma_{t\bar{t}}LO = 6.23 \pm 0.003$ pb $\qquad$ $\sigma_{t\bar{t}}NLO = 8.39 \pm 0.037$ pb

For $t\bar{t}\gamma$ the cross sections at LO and NLO were found to be :

- $\sigma_{t\bar{t}\gamma}LO = 0.026 \pm 0.0087$ pb $\qquad$ $\sigma_{t\bar{t}\gamma}NLO = 0.028 \pm 0.0001$ pb

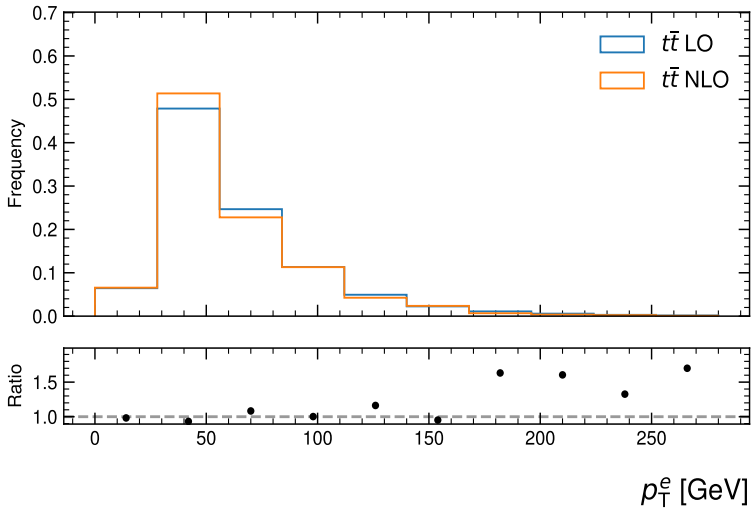
Distributions of $\Delta\phi^{e\mu}$

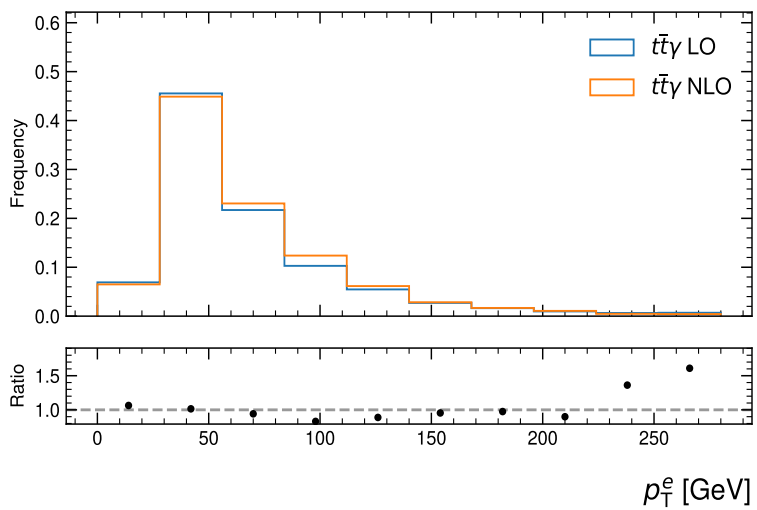


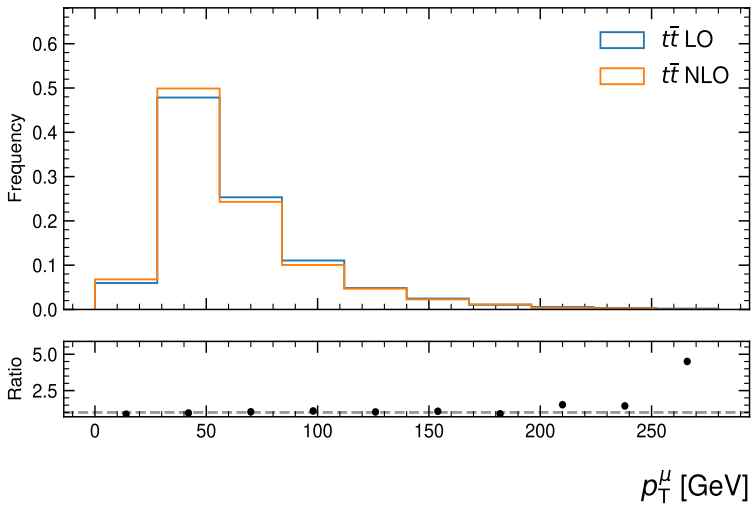


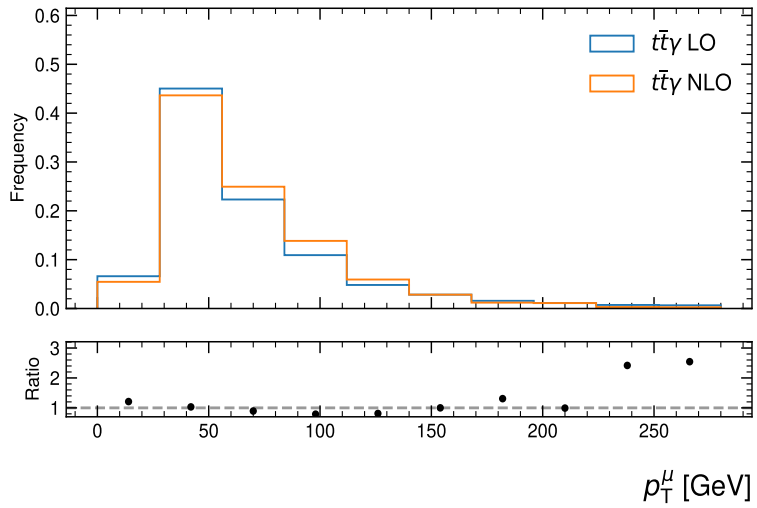
- Distributions of $\Delta\phi$ between e and μ for $t\bar{t}$ and $t\bar{t}\gamma$ processes.
  - We represent the LO and NLO distributions in blue and orange colored histograms.
- The LO data is compared to the NLO data in the ratio plot.

Distributions of electron and muon p_T



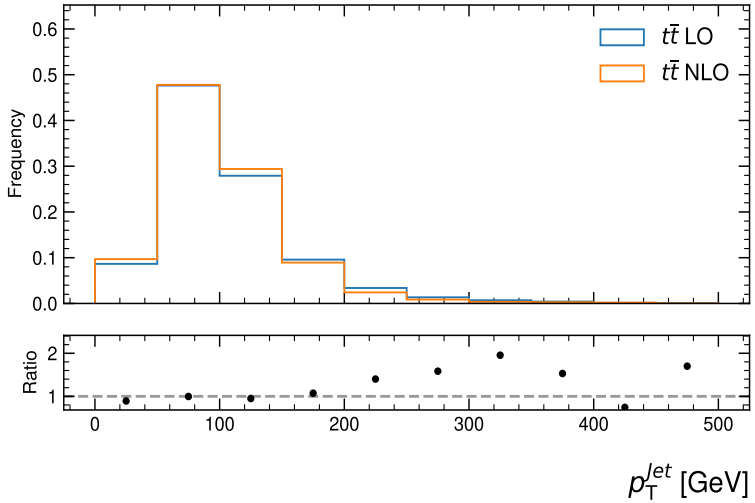


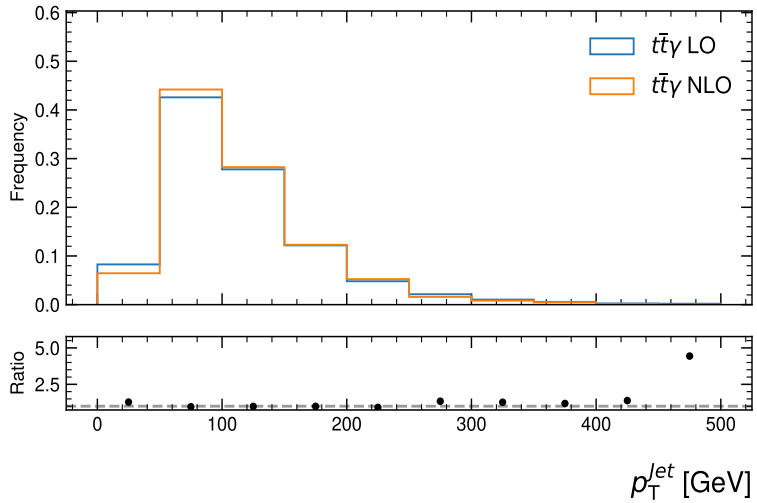


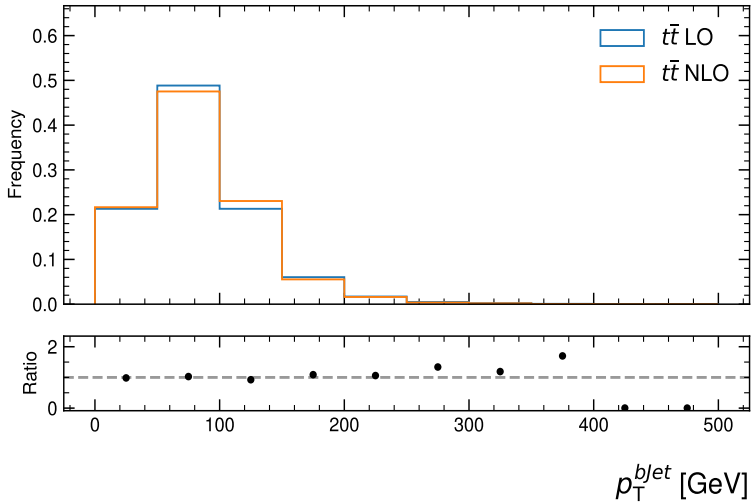


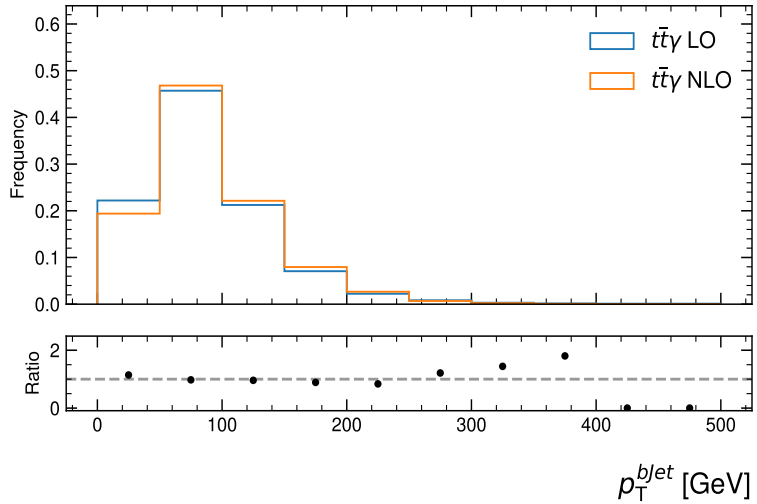
- Prediction ratios of LO data to NLO data as a function of electron(e) and muon(μ) p_T.

Distributions of jets and b-tagged jets



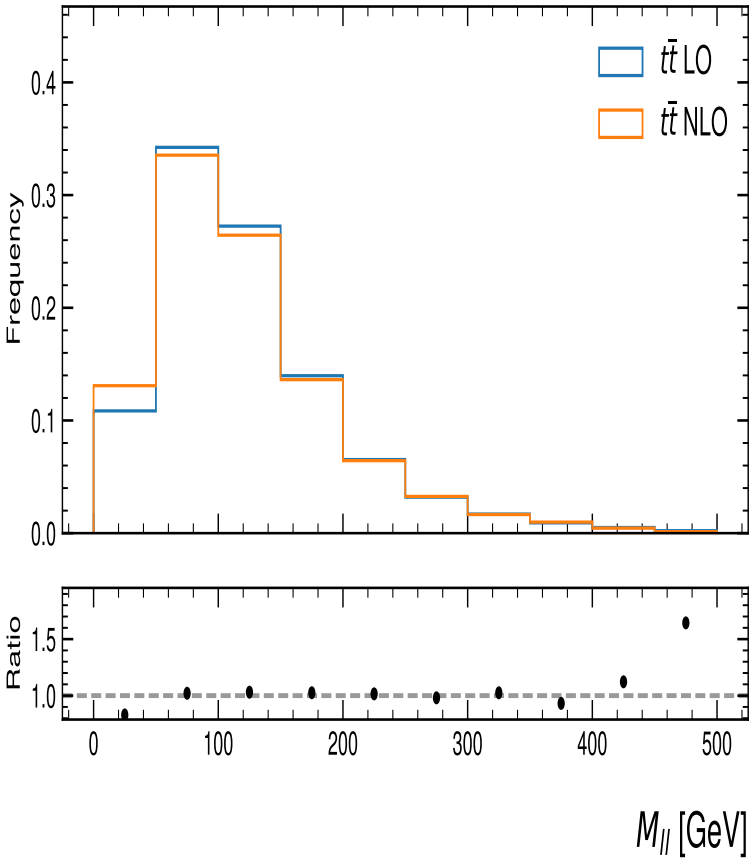


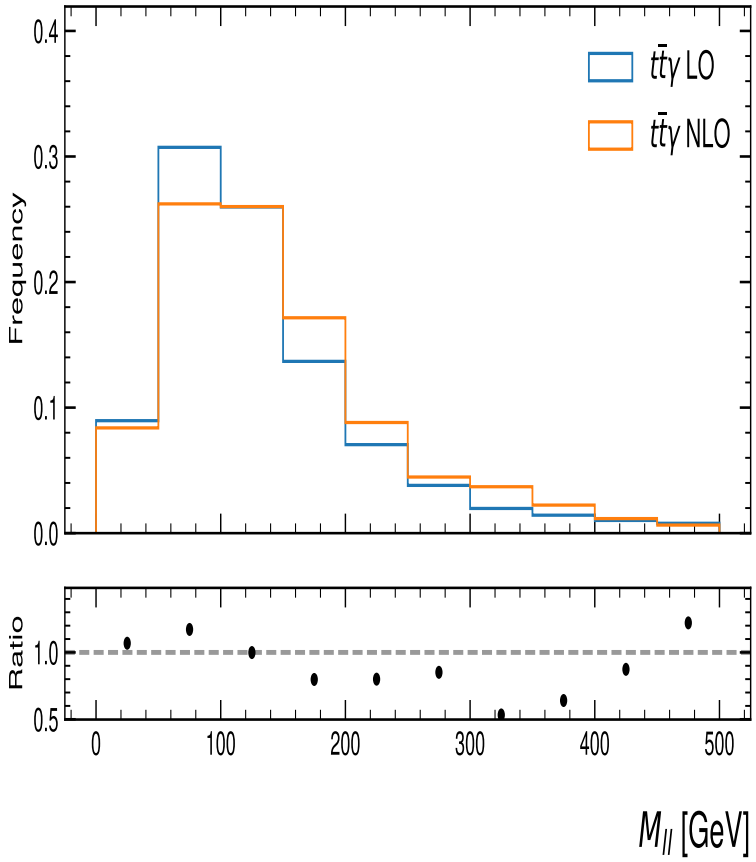




- Distributions of jets p_T and b-tagged jets p_T for $t\bar{t}$ and $t\bar{t}\gamma$ processes.

Invariant mass distributions





- Invariant mass between an electron and muon for $t\bar{t}$ and $t\bar{t}\gamma$ processes.

Conclusion

- Measurements of the cross-section of $t\bar{t}$ & $t\bar{t}\gamma$ process in the $e\mu$ decay channel are presented using pp collisions at a center-of-mass energy of 13 TeV.
- For the estimation of efficiencies and acceptance corrections, a LO & NLO Monte Carlo simulation of the 2→7 (2→6) process $pp \to e\nu\mu\nu bb\gamma$ ($e\nu\mu\nu bb$) was used for the $t\bar{t}\gamma$ ($t\bar{t}$) part of the signal.
- The discrepancy between data and Monte Carlo is larger in $t\bar{t}\gamma$ signal compared to $t\bar{t}$ signal.

Thank you!