

Search for exclusive top quark pair production at the LHC

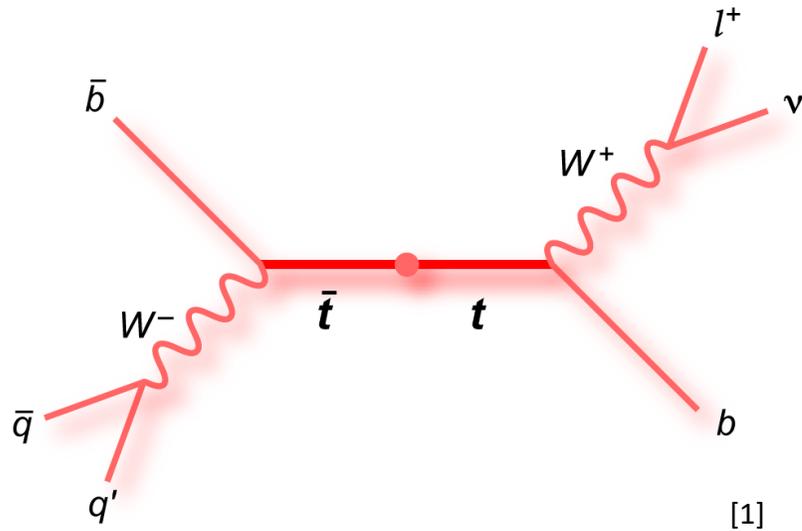
Summer Internship

Supervisors: Beatriz Ribeiro Lopes
Dr. Michele Gallinaro

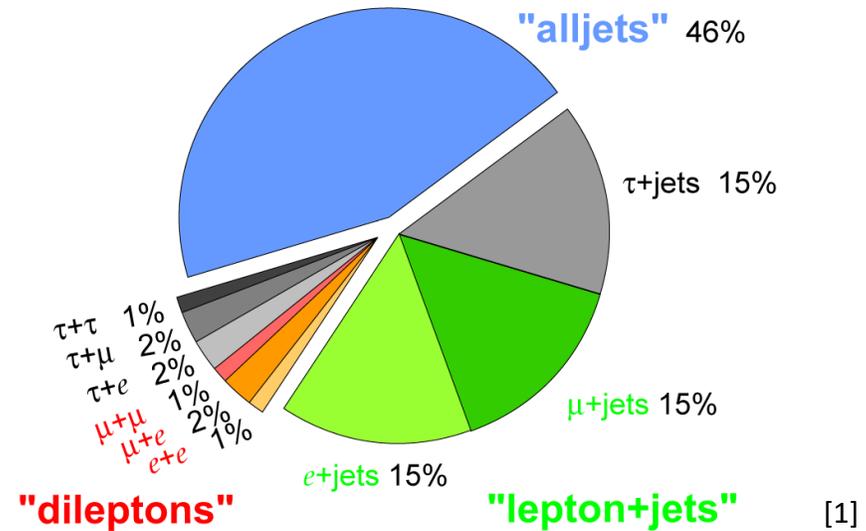
Miguel Nobre Guerreiro



Brief Introduction



Top quark -> b-jet + W boson

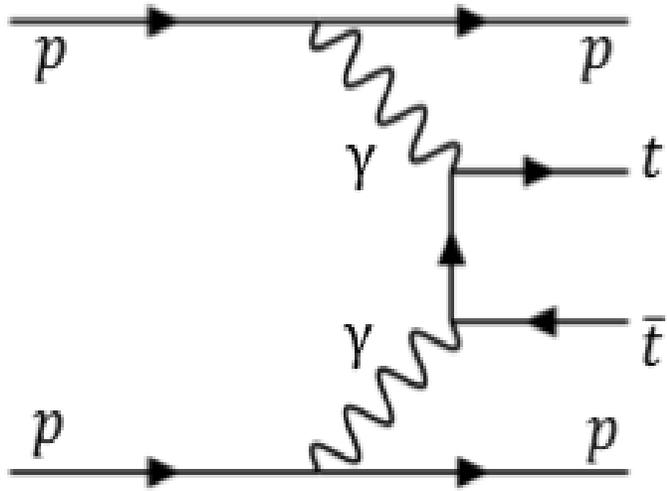


We are interested in the dileptonic decaying channel

[1] https://www-d0.fnal.gov/Run2Physics/top/top_public_web_pages/top_feynman_diagrams.html



Exclusive $t\bar{t}$

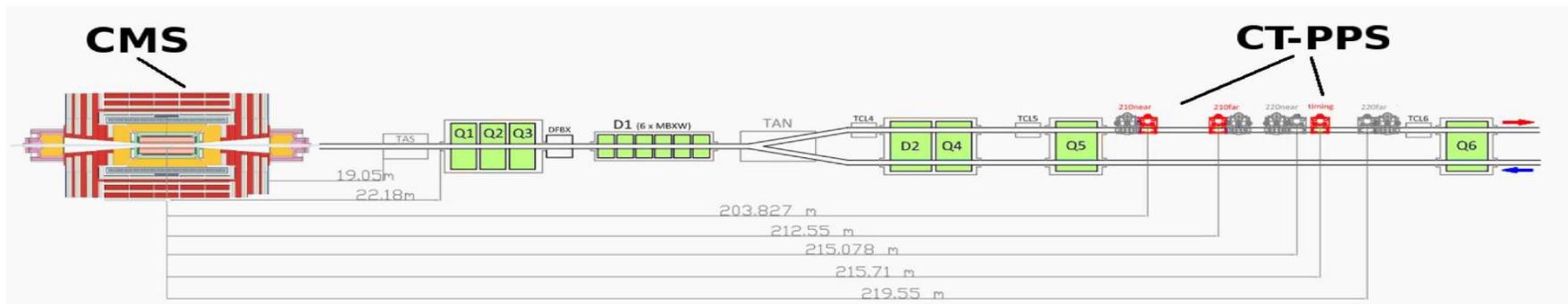


- Dileptonic decaying channel
- Photon-photon interaction
- Missing transverse energy (met) due to neutrinos
- Protons preserved and detected by the PPS (allow the kinematic reconstruction even with met)

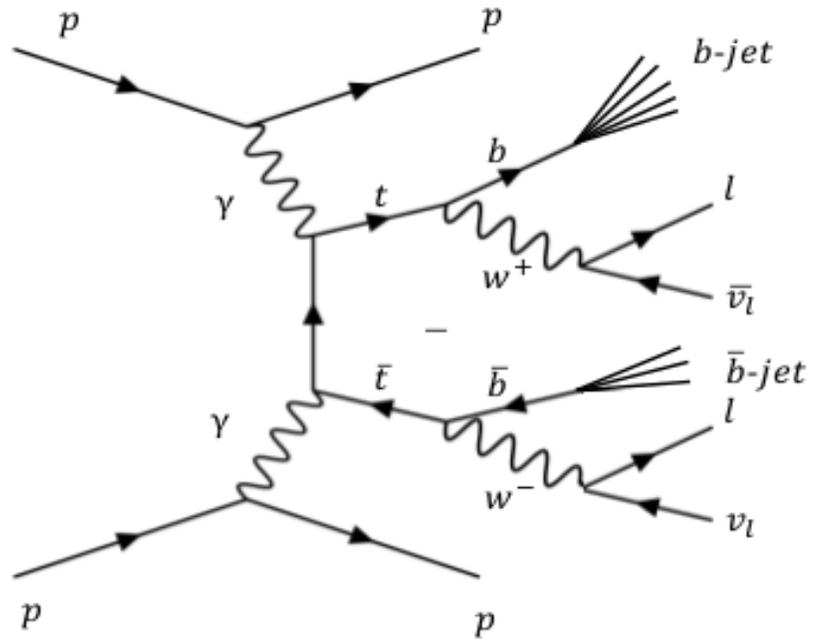
PPS Detector

(Proton Precision Spectrometer)

- LHC magnets bend scattered protons outside of the beam envelope
- Roman Pots placed a few mm from the beamline
- Detect protons at about ± 200 m of the IP (positive and negative sides)



Central Selection



Require for leptons:

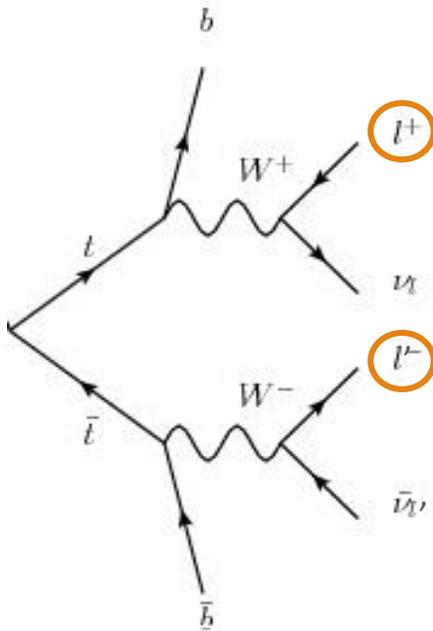
- ≥ 2
- $|\eta| \leq 2.5$
- $p_T \geq 13 \text{ GeV}$

Require for jets:

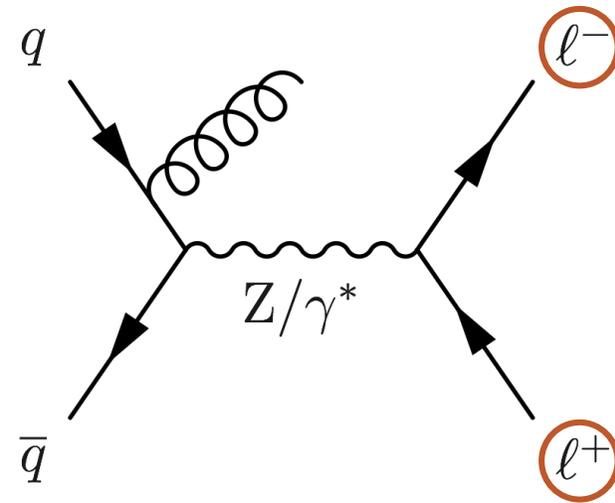
- ≥ 1
- ≥ 1 b-jet

Main Background

Inclusive $t\bar{t}$



Drell-Yan



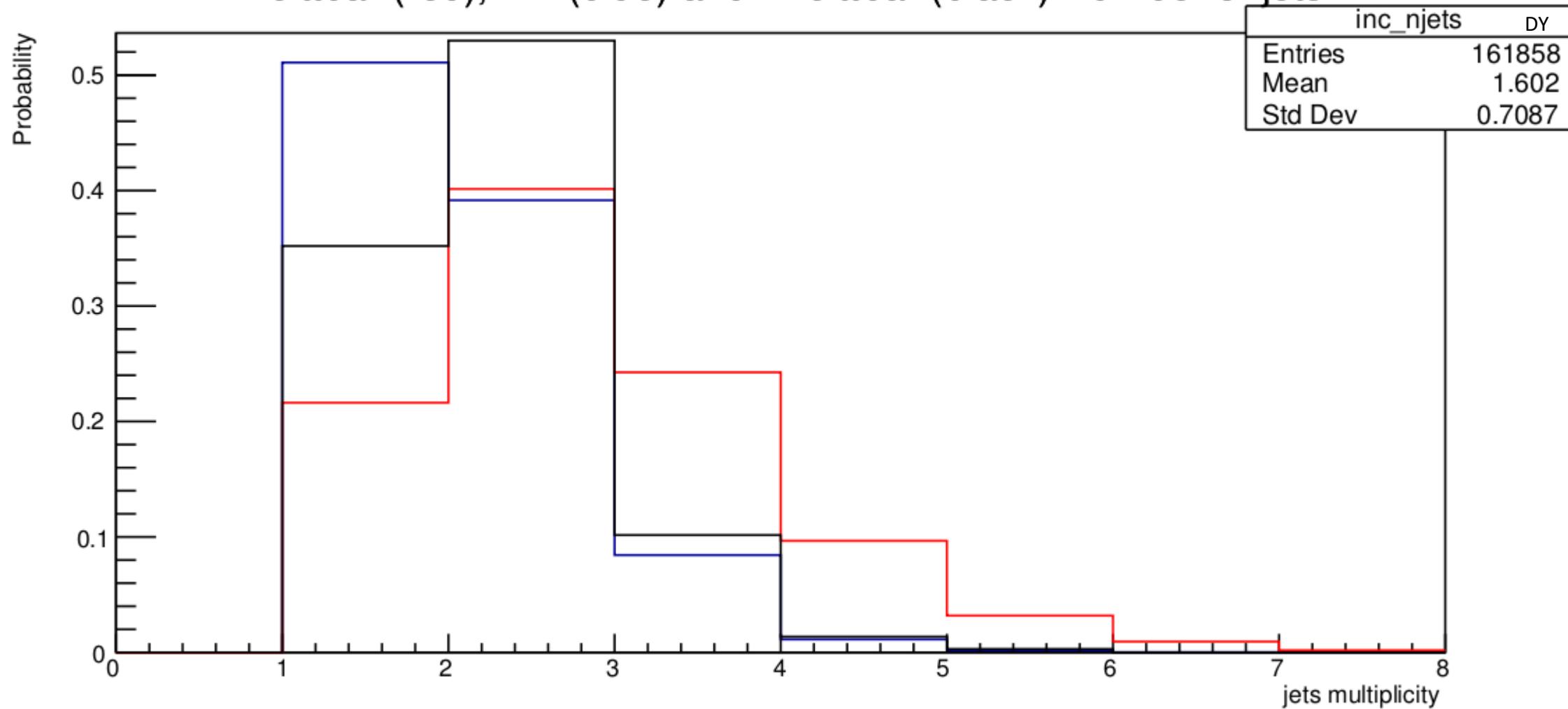
Kinematic Analysis

- Monte Carlo samples from 2017
 - Inclusive $t\bar{t}$
 - Drell-Yan
 - Exclusive $t\bar{t}$
- $\sqrt{s}=13$ TeV

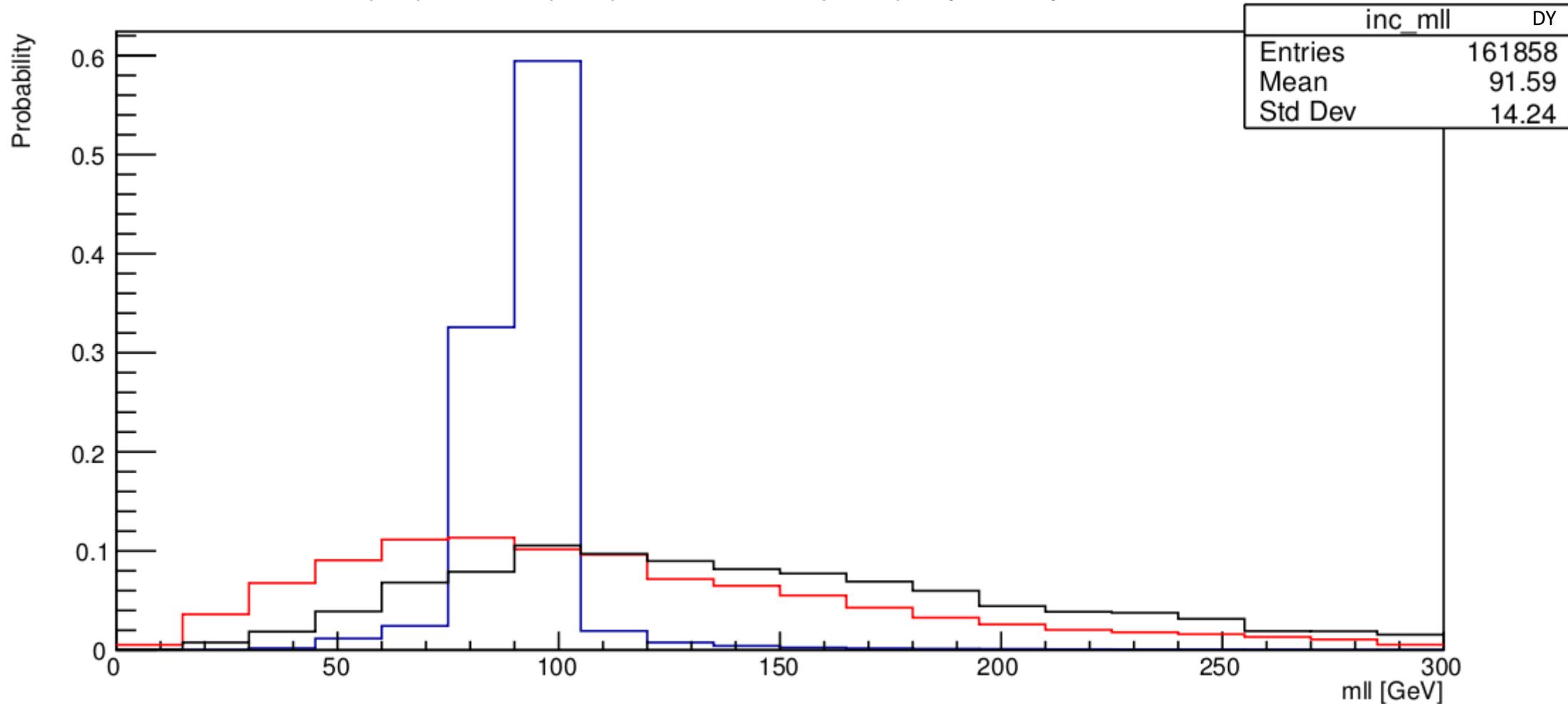
Tools for multivariable analysis on real data



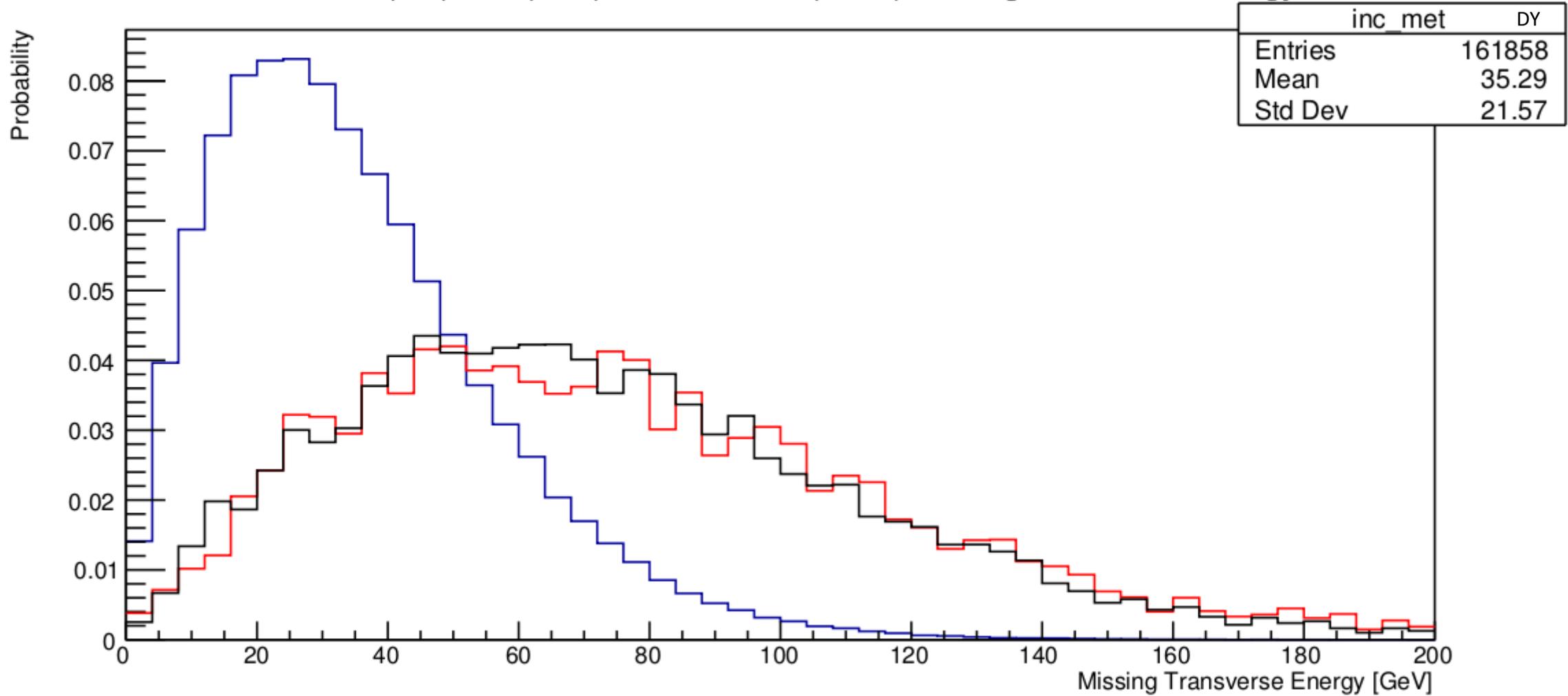
Inc ttbar (red), DY (blue) and Exc ttbar (black) Number of jets



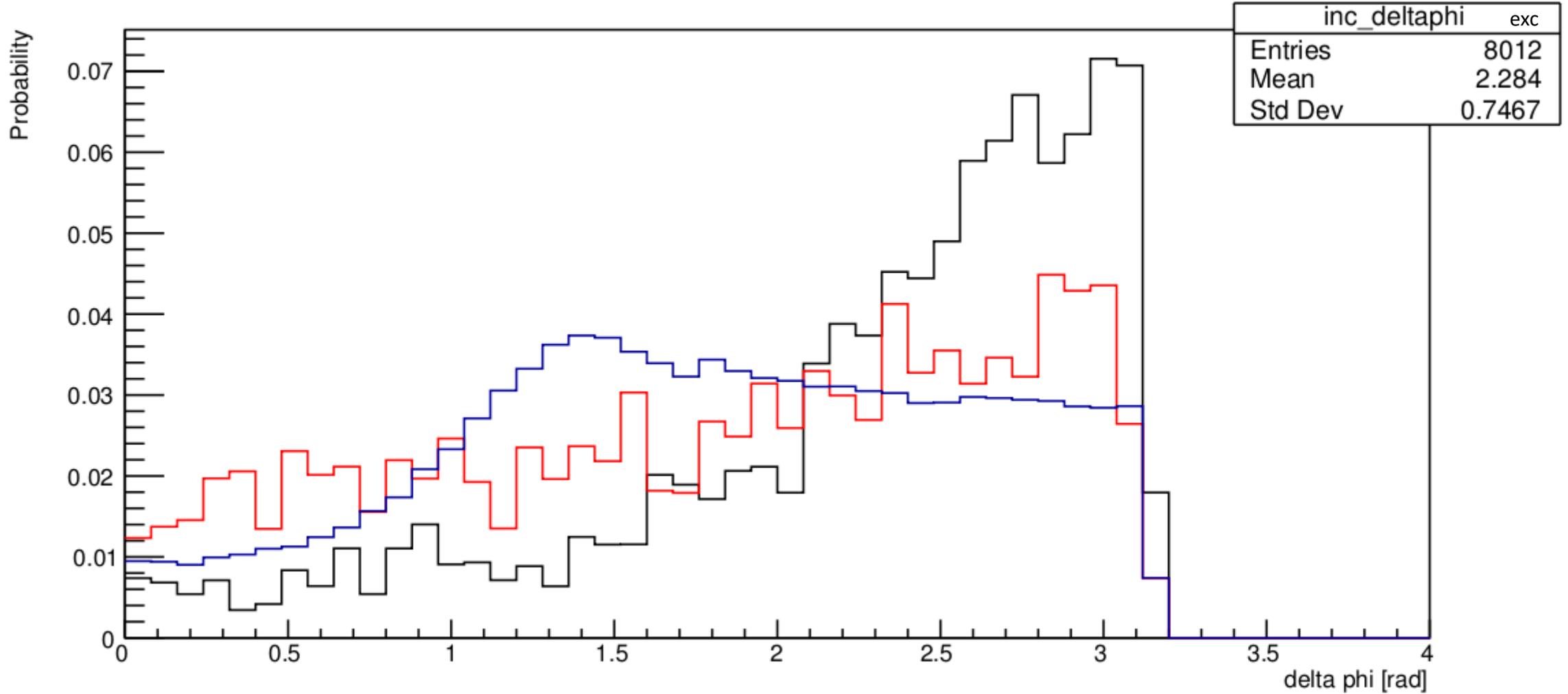
Inc ttbar (red) and DY (blue) and Exc ttbar (black) Lepton-Lepton Invariant Mass



Inc ttbar (red), DY (blue) and Exc ttbar (black) Missing Transverse Energy



Inc $t\bar{t}$ (red), DY (blue) and Exc $t\bar{t}$ (black) Lepton-Lepton Angular Difference (Transverse Plane)



Further Goals

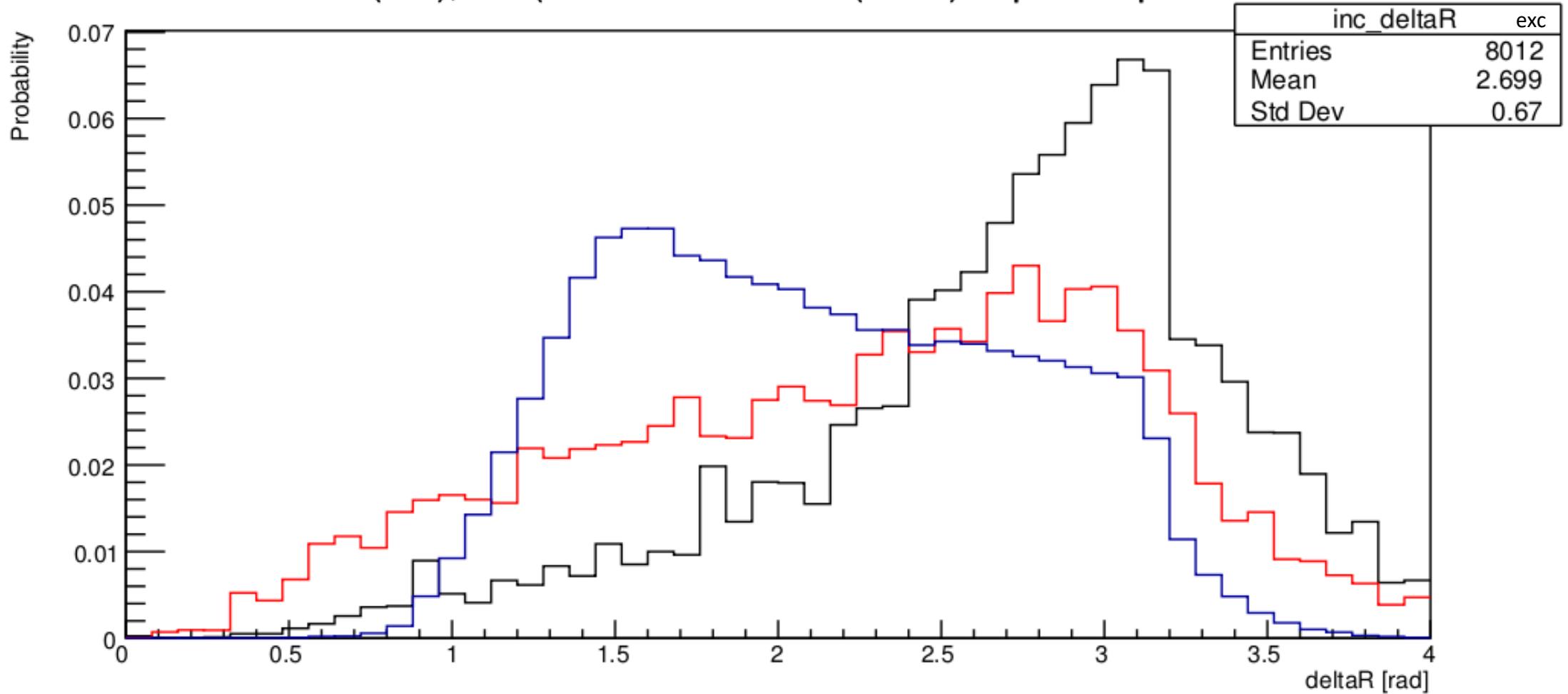
- Better highlight the differences between inclusive and exclusive $t\bar{t}$
- PPS-RP: $\xi(\text{ll})$ Vs $\xi(\text{pp})$

Thank you!

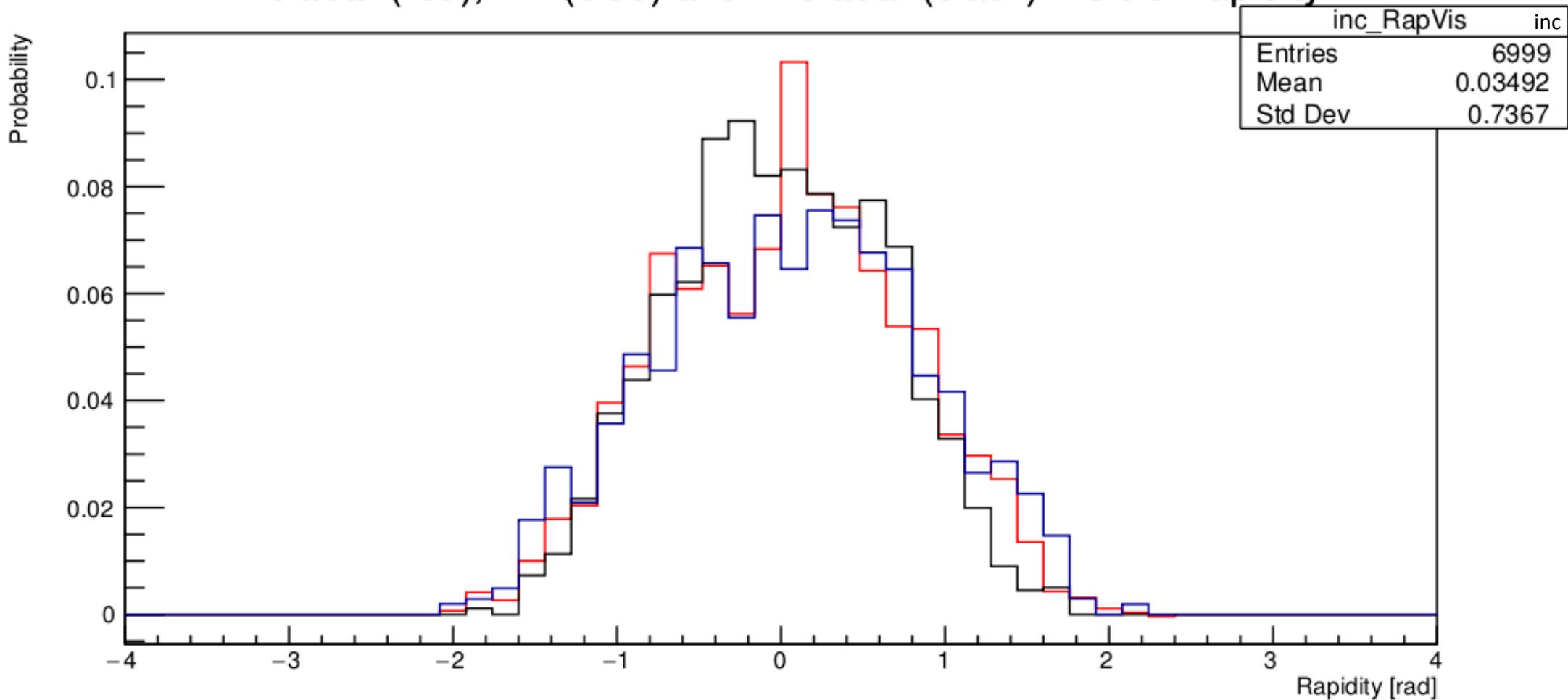


Backup

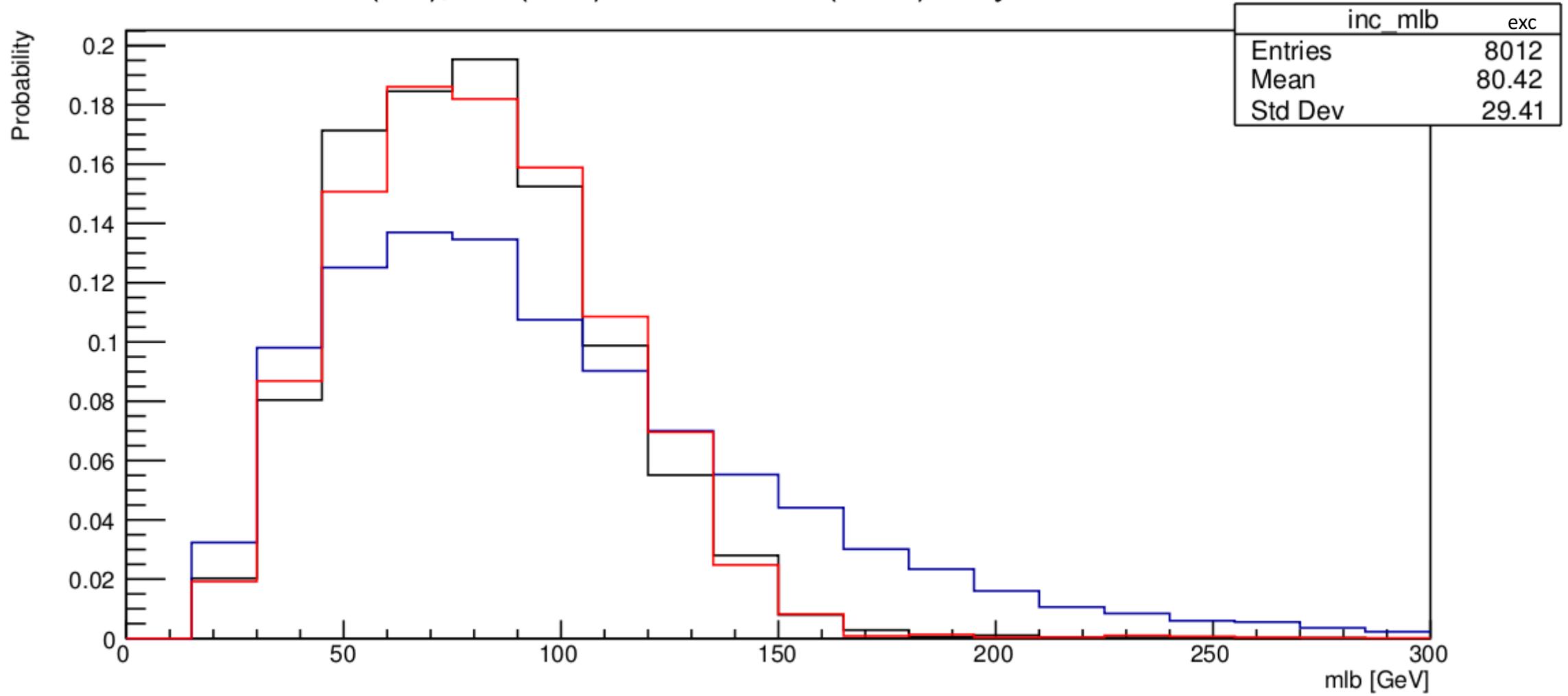
Inc t \bar{t} bar (red), DY (blue and Exc t \bar{t} bar (black) Lepton-Lepton deltaR



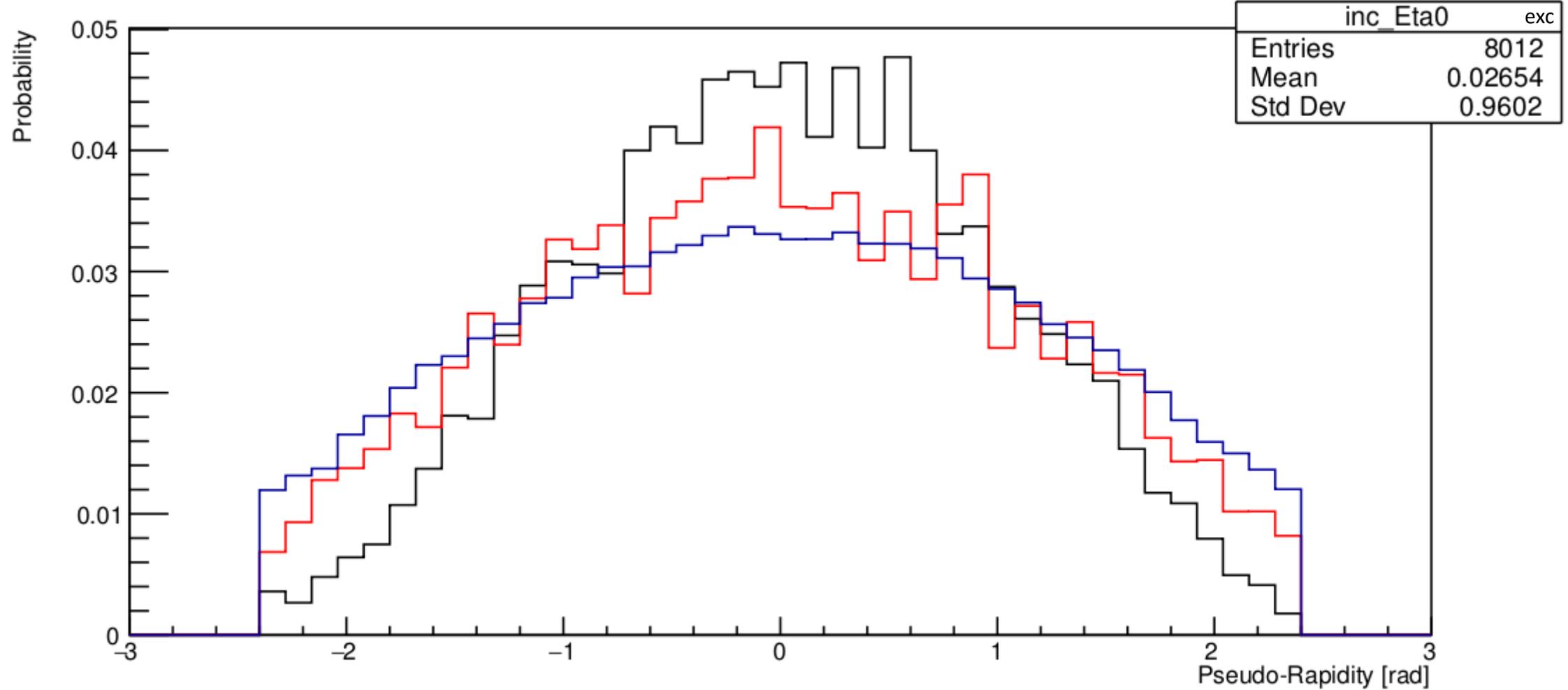
Inc ttbar (red), DY (blue) and Exc ttbar (black) Visible Rapidity



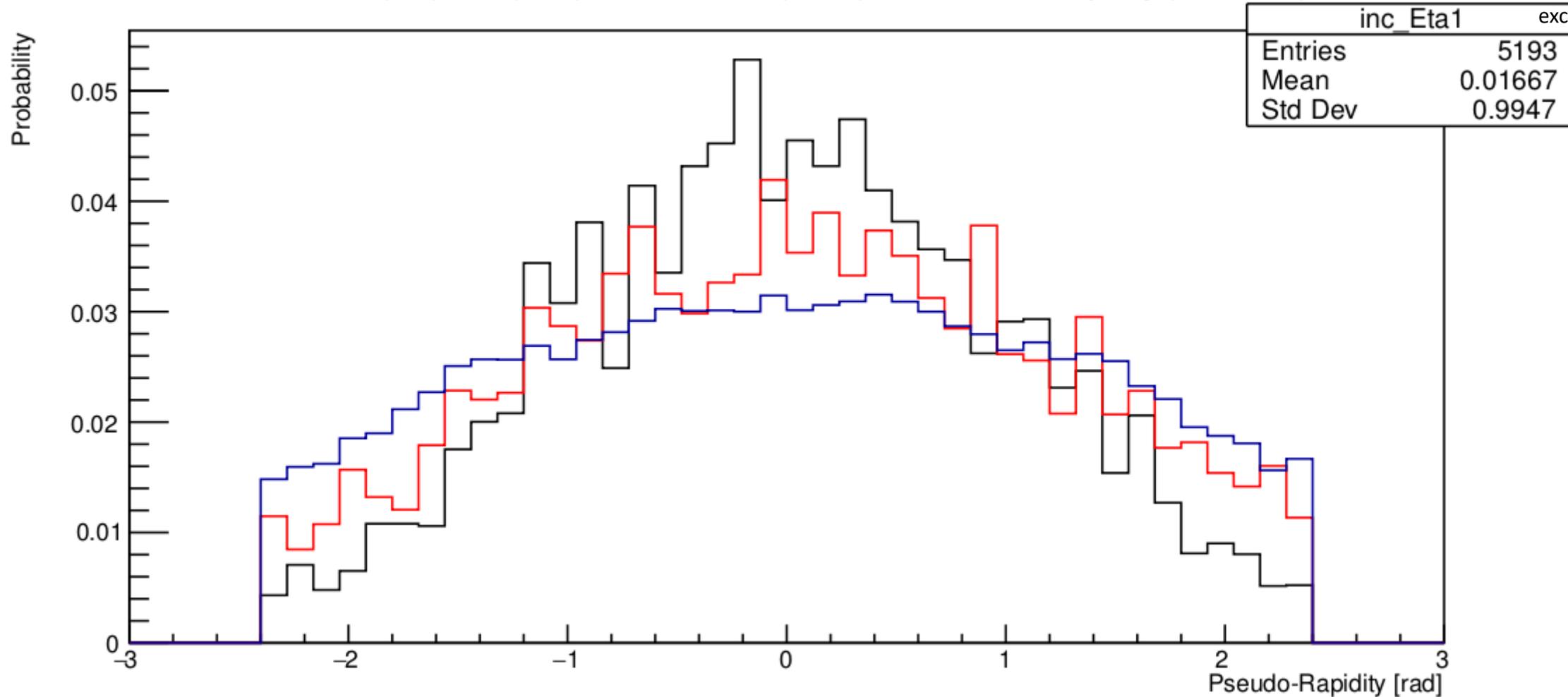
Inc t \bar{t} bar (red), DY (blue) and Exc t \bar{t} bar (black) lb-system Invariant Mass



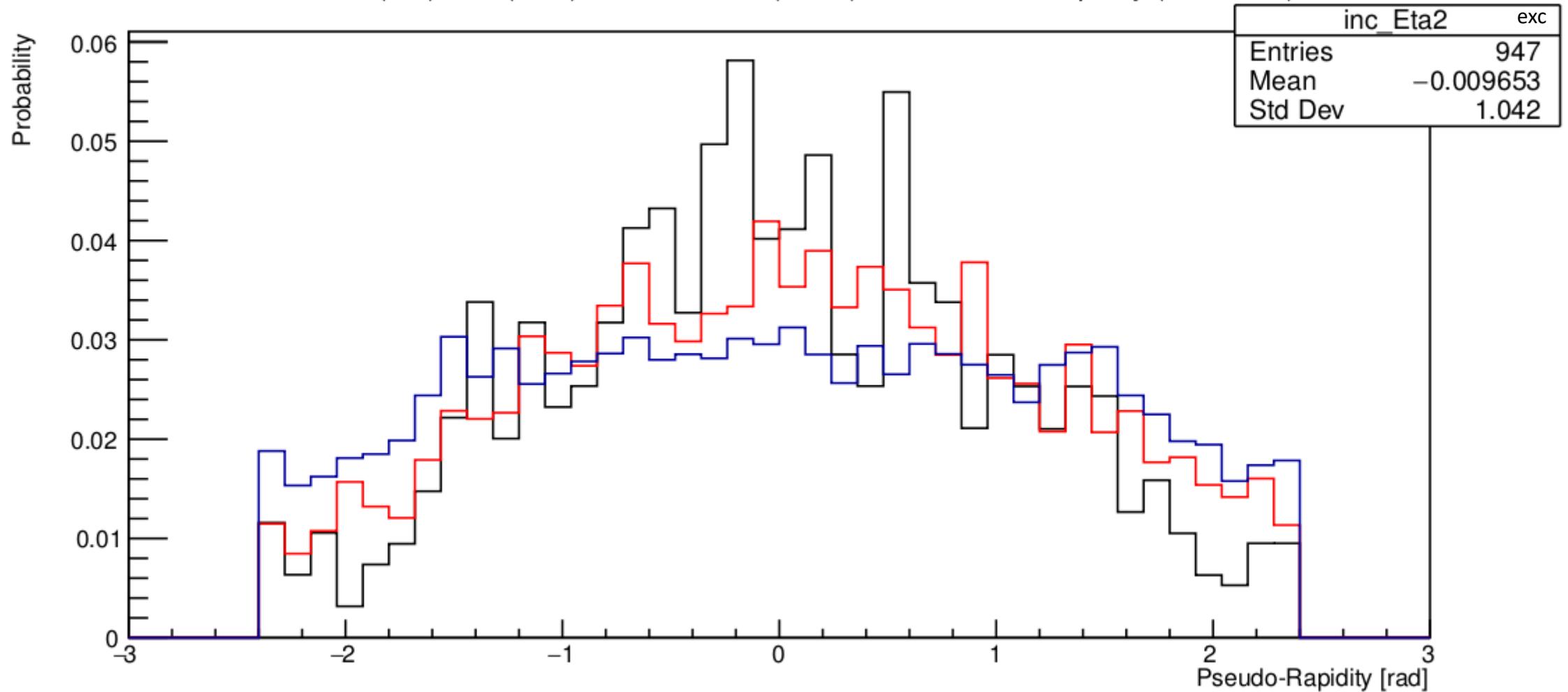
Inc ttbar (red), DY (blue) and Exc ttbar (black) Jets Pseudo-Rapidity (for Jets 1)



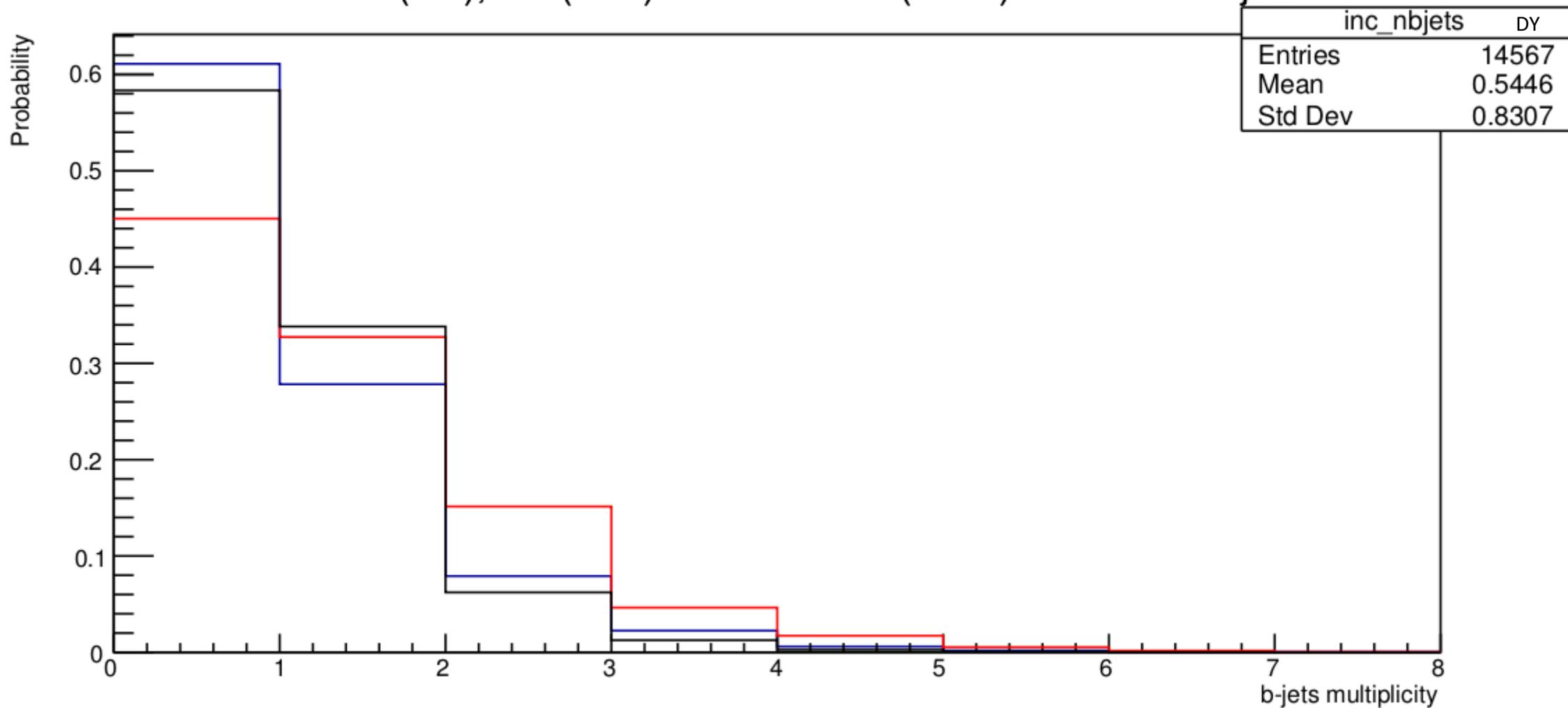
Inc t \bar{t} (red), DY (blue) and Exc t \bar{t} (black) Jets Pseudo-Rapidity (for Jets 2)



Inc ttbar (red), DY (blue) and Exc ttbar (black) Jets Pseudo-Rapidity (for Jets 3)



Inc ttbar (red), DY (blue) and Exc ttbar (black) Number of b-jets



Forward Tracks IN PPS

- From each track we get the momentum loss of the proton
- Reconstruct tracks on both sides (ξ_1 and ξ_2)
- We can reconstruct the **mass** and **rapidity** of the system

$$\xi = \frac{p_i - p_f}{p_i}$$

1 per track in the RP



for every possible combination

$$m_{RP} = \sqrt{s \xi_1 \xi_2}$$

$$y_{RP} = \frac{1}{2} \ln \left(\frac{\xi_1}{\xi_2} \right)$$

check which mass and rapidity values are compatible with what we are looking for!

